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SPACE LAUNCHINGS AND FINISHES

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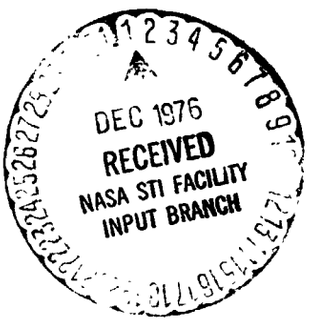

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16 Abstract

The monograph gives a chronological account of preparations for and implementation of the Russian manned space program from its inception through the "Soyuz-Apollo" program as seen through the eyes of a Russian sports commissar who was always on the scene of launchings and landings of Soviet cosmonauts.

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SPACE LAUNCHES AND FINISHES

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[Excerpts of monograph by I. G. Borisenko]

TABLE OF CONTENTS

Page

International Aeronautical Federation..... 2

"Vostok" Program..... 7

"Voskhod" Program.....21

"Soyuz" Program.....29

The Storming of Space is Continuing.....59

Photo Captions.....74

INTERNATIONAL AERONAUTICAL FEDERATION (IAF)

[Text] Late in the nineteenth century, both in our country and abroad, flightcraft began to appear which made flights at low altitudes, with small speeds, short range and low load-lifting capacity.

To be sure, the creators of the first aircraft had no easy task. The fact is that the designed heavier-than-air craft had to fly in an atmosphere which at that time was still poorly studied. But already by 1904 enthusiasts had been able 141 times to launch balloons with automatic instruments which attained altitudes of 14 kilometers.

Investigation of the upper layers of the atmosphere had its positive results. By 1910 scientists, together with the designers of flightcraft, had created the fundamental theoretical precepts of aerial navigation and were effectively working with the laws of mechanics, hydromechanics and aerodynamics. As a result, aircraft became more durable and stable and made flights at relatively great altitudes and for a long time.

Already during this period there was a need to keep track of the first attainments of aviation. A number of countries proceeded with initiative for creating an international agency which would coordinate and keep track of attainments in aviation with respect to its principal technical flight and sports indices. And then on 14 October 1905 the International Aeronautical Federation (IAF) was established.

The constituent congress, which was attended by representatives of eight countries, in an appeal to other countries, stated: "Recognizing the particular importance of aviation, the congress expresses the wish that an organization be established in each country for performing the function of regulating aviation sports and popularizing aviation."

Now more than 60 countries in the world are members of this international organization. The IAF monitors aviation achievements throughout the world, compares them and thereby favors the development of designing thought, aviation, aviation sports, air tourism, their progress, enhancement of the sports mastery of fliers, glider pilots, parachutists and builders of model airplanes.

It also oversees advances in astronautics and interplanetary flights, registering records in this field as well. This organization has a carefully formulated and constantly revised aviation sports code which regulates the order of setting of world records and overseeing international championships and sports meetings.

The IAF is the sole international organization under whose auspicies the national aeroclubs carry out international meetings for all kinds of aviation sports. These competitions are annually organized in different countries of the world, becoming a good tradition. They favor the strengthening of cordial international relationships.

On the day of its sixtieth anniversary, 14 October 1965, the IAF had registered 581 world records, of which 236 are held by the Soviet Union. These records are evidence of the vigorous development of aviation. Whereas in 1909 the international flight altitude record for aircraft was 155 meters, it is now 34,714 meters. The speed record in 1906 scarcely exceeded 40 km/hour, whereas at the present time it is 3,331 km/hour. [The American X-15 rocket plane, launched from a mother aircraft, attained an altitude of 95,936 m and a speed of 6,693 km/hour.] The flight range record in 1906 was only 220 meters. Today it has exceeded 20,000 km. The load-lifting capacity of modern jet aircraft has attained 55 tons and the record for helicopters is 20 tons.

The rapid development of science and technology, especially rocketry, posed before the IAF the problem of formulating new rules and regulations which would make it possible to register outstanding world attainments in manned spaceflight.

At a session of the International Sports Commission of the IAF at the 53d General Conference in October 1960 at Barcelona the representatives of 22 countries, including the USSR, United States, Great Britain, France and others discussed this problem. The General Conference as absolute world records for manned spaceflight decided to recognize and register the following:
-- for flight duration;
-- for altitude in nonorbital (ballistic) flight;
-- for altitude in orbital flight (flight around the earth);
-- for maximum mass (weight) of a spaceship launched to an altitude of 100 km or more from the earth.

It was unanimously decided that the IAF would recognize only records established as a result of spaceflight beyond the limits of an altitude of 100 km. Celestial spaces up to 100 km were reserved for further records of aviation.

It was also established at the General Conference that a record would be deemed such when the spaceship pilot or crew returned safely to earth after achieving the maximum result. In order for the record set in space in a

spaceship be officially recognized and registered it is necessary that after the flight a protocol on the record flight be submitted to the IAF for its approval.

The protocol must include data on the launching, flight and landing and also general information on the flier-cosmonaut, on the type, make and power (thrust) of the carrier-rocket, results of processing of all data by the coordination-computation center, a report on spaceship design and construction, telemetric information, brief description of measuring instruments, flight program, a personal report of the flier-cosmonaut about flight in the ship and many other materials with sketches, computations, tables and graphs representing all parameters and data for the space flight. In addition, it is necessary to indicate the nationality of the ship's pilot and its crew, the number and date of the ship commander's sports card, and also the spaceship identification marks. Thus, for the first time in the history of existence of the IAF a decision was adopted on the registry of space records. The conference delegates approved it and regarded it as a step reflecting the aspirations of the Federation to keep step with the vigorous development of science and technology.

After the illustrious triumph of Yu. A. Gagarin, the first man who had entered space in the "Vostok-1" spaceship, a special Astronautical Commission was created in March 1962 for examining materials on space records and for their registry by the IAF. It was made up of representatives of Great Britain, Belgium, Italy, France, Poland, USSR, United States, CzSSR and other countries. The representative of the Soviet Union was elected vice president of this commission.

On 5 May 1961 a suborbital flight was made by the American astronaut Alan Shepard; on 21 July 1961 a similar flight was made by Virgil Grissom. And on 6-7 August 1961 the Soviet cosmonaut German Titov made a daylong orbital flight around the earth. This forced the Astronautical Commission of the IAF to reexamine the rules for registry of records of cosmonauts and astronauts. The commission defined new categories of flights: suborbital or ballistic flights and orbital flights. A work program was laid out for determining the rules for registry of records during man's flight to other planets of the solar system.

Space records are distributed by classes: world records, world records of the class of orbital and suborbital flights. They apply to duration (from the launching point to the touchdown point); altitude attained above the earth's surface; maximum mass carried aloft; flight distance along the trajectory from the launching point to the point at which motion ended.

With the further accumulation of experience in spacecraft flights the International Astronautical Commission of the IAF will make timely changes and corrections to the sports code. At the present time the IAF is keeping track and registering the scientific-technical and record attainments not

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only of manned vehicles but also automatic stations making flights both around the earth and to other planets of the solar system.

In order to delve into the classification of records set by man not only in spaceships and on space stations, but also on other flightcraft (aircraft, helicopters, etc.), we will familiarize ourselves with the general regulations which determine different categories of records.

What is a record? It is the best result which has been obtained with a flightcraft under the conditions determined by the sports code.

Records are divided into national and world. World records can be only those which correspond to the conditions of the IAF sports code and which have been approved by the IAF. World records are distributed by classes. National records are set in accordance with the rules or regulations of some country In such cases the flightcraft commander must be a citizen of the pertinent country. In addition, the IAF also recognizes absolute world records. What does this mean? An absolute world record is the best absolute result of any flightcraft attained in an especially important field independently of the classification or category.

It is written in the IAF sports code that a new attainment can be deemed an absolute world record only in a case when it surpasses the old record for spaceflights by not less than 10% and for flights of other flightcraft by not less than 1%. Here it is noted, moreover, that during a flight for the purpose of establishing a record a flight program must be prepared before the launching. This program is approved by a national aeroclub, association or federation. This program includes a description of the mission which the cosmonaut received during the entire period from the launching to the landing; the landing method which will be used, etc.

The protocol on the record flight should include documents on the launching and landing and on the weighing of the spaceship and flier-cosmonaut in full flight gear, documents on the setting of records for duration, altitude, flight distance and maximum mass carried aloft, and data on the carrier-rocket. All this is registered and checked by the sports commissars who are present during the launching and finish as representatives of the IAF. The commissars (commissioners)are designated by the national aeroclub or aviation federation (association).

In the IAF sports code, in the chapter entitled "Responsible Persons," the sports commissars (commissioners) are first in the list of responsible persons who officially represent the IAF in an aviation competition. They are delegated absolute authority. During the launching of spaceships with flier-cosmonauts the sports commissars see to the execution of all the rules and conditions for the registry of data involved in the setting of records.

In the case of a record flight of any flightcraft, in addition to a spacecraft, only the sports commissar has the right at the starting point, before the takeoff, to check and seal all the measuring instruments for determining flight altitude, range and speed, and also check the load weight. After the landing only the sports commissar at the landing site can remove the measuring instruments; only he certifies the intactness of the seals on the instruments and notes this in a special document. No world record can be presented for confirmation by the IAF if it has not been checked and measured in accordance with the set rules by an official representative of the IAF -- the sports commissar.

Before the launching, and also after the finish, the pilot or flier-cosmonaut, the spaceship commander mandatorily shows the sports commissar the standard IAF sports certificate attesting to who he is. Such a certificate is issued to the pilot by the national aeroclub of the country; it is valid in all the countries represented in the IAF. Its holder has the right to participate in all open sports competitions.

In addition to the sports commissars, for registering the records set by any flightcraft (including a spacecraft) there may also be timekeepers, technical commissars, deputy commissars, etc. They are all subordinate to the sports commissar. It may be that the presence of several representatives is required during the registry of records. Then the sports commissar can designate a deputy. When the protocol on the record is ready, it is discussed and approved in the sports commission of the national federation and only then is sent to the IAF. In his activity the sports commissar is responsible to the sports commission.

As early as 1962 the presidium of the Federation of Aviation Sports (FAS) of the USSR created in the sports commission a group of sports commissars for the registry of records established by man during space flights. This group is occupied not only with the registry and certification of space flights, but also solves problems related to sports cosmonautics.

All our sports commissars are members of the Sports Commission FAS USSR. They have the necessary knowledge in the field of theory and practice of manned space flights. They are participating in the formulation of new rules and regulations on determining and registering the records set with spaceships and automatic stations.

A Federation of Aviation Sports, which is a member of the IAF, has been established in the Soviet Union. The USSR Federation of Aviation Sports is made up of federations of aviation types of sports and also different commissions, including the commission on sports-technical problems in cosmonautics. The members of this commission are scientists, engineers, officials who are concerned with the study and conquest of space.

"VOSTOK" PROGRAM

Man in Space

[Text] Our country is rightfully regarded as the motherland of the first space launchings. On 4 October 1957 all mankind became a witness of the world's first flight into space of a Soviet artificial earth satellite. This was followed by the launching of the next artificial satellites into an orbit around the earth and then test flights of spaceships, and finally, flights of interplanetary automatic stations. Before man's first flight into space there were more than 50 launchings of flightcraft, by means of which the necessary investigations were stubbornly and scrupulously carried out.

March 1961. This month was the most strained for those who were making preparations for flight of the "Vostok" ship, including the carrier-rocket and the launching complex, and especially for those who were making ready for the impending flight.

The fifth satellite-ship weighing 4,695 kg was put into an orbit around the earth in the USSR on 25 March 1961. Its cabin held a dummy cosmonaut, the dog "Zvezdochka" and different biological objects. The ship successfully carried out the program and after one orbit around the earth made a landing. The on-board apparatus, instrumentation, ship's orientation system, braking engines, manual control, descent and landing systems, radio equipment, and devices for monitoring the flight and registering man's physiological functions were checked once again. The launching and flight of the satellite-ship revealed that the stage of preparation for man's flight into space had been completed.

A group of cosmonauts was intensively prepared in accordance with a special program. Every one of them knew well that only one of them would have the great honor of being the first to open the way into the expanses of space. Their training was the constant concern of all those who directed the preparations for the flight. Two cosmonauts were selected for participation in the first space flight.

Stressed and meticulous work went on at the cosmodrome on these days. The engineers, technicians and workers more than once had to launch space rockets into space from the launch pads. But now for the first time a man was being launched into flight aboard a spaceship.

We sports commissars also made our preparations. We were to be not only witnesses of the flight, but would also register new records, space records, in the annals of the International Aviation Federation. In February 1961 I was called by General N. P. Kaminin, who stated that the launching of a manned spaceship was being planned. He asked whether there were rules or regulations in the sports code concerning the registry of space records. I responded that in October 1960 at Barcelona the 53d General Conference of the IAF had approved rules for the registry of space achievements established by man during flight into space. Later I reported on this to Academician S. P. Korolev and members of the State Commission who had been given the right to make decisions concerning the first launching of a man into space.

The people directly engaged in the preparation of the cosmonauts, technical specialists, and also we, the sports commissars, flew in to the cosmodrome. Baykonur greeted us with warm, sunny weather. The sun shone like spring; the desert steppe had come alive after the severe winter frosts and severe blizzards. Among the designers and scientists who had gathered together, who had participated in creating the spaceship, many complex theoretical problems had been solved concerning the implementation of flight and ensuring man's safety.

During the several days before the launching we weighed the "Vostok" spaceship and prepared the necessary materials which after termination of the flight had to be incorporated into the report on this space journey.

12 April 1961. The time of the launching is approaching. Over the radio one hears that it is one hour until "go!" Then a half-hour. The launch pad is deserted. Everyone who was to service the launching was in his place. The spaceship stands as if looking up into the celestial expanses, studying the path along which it for the first time is to carry man into space.

The TV screen clearly shows the cosmonaut's face. He is cheerful and happy. "I feel well, my gloves are on, the space helmet is fixed in place, I am ready for the launching," reports Yuriy Gagarin.

"Attention -- one minute to go!"

"'Kedr'! This is 'Zarya-One'. Attention, a minute to go! A minute to go!"

From the bunker where the control panel is situated, one hears the voice of the launch director:

"Switch for launching!"
"The launching switch is thrown!" responds the operator.

"Draw away one!"

"One is drawn away!"

"Scavenge!"

"Scavenging accomplished!"

"Drainage switch!"

"Drainage switch thrown! Drainage accomplished!"

"Ignition!"

"'Kedr'! This is 'Zarya-one'. Ignition!"

And Gagarin's voice is heard from the loudspeaker:

"All is understood, ignition OK..."

"Preliminary!"

"Preliminary OK."

"Intermediate... Main! Liftoff!"

The last seconds! All eyes are turned to the spaceship. In the silence which sets in one can hear the voice of the timekeeper: "One..., two..., three..." These are the seconds.

It can be heard over the radio how Gagarin says: "On my way! Everything is proceeding normally!" The increasing thunder of engines is heard. In the flames bursting from the engine nozzles the body of the rocket seemingly unwillingly rises above the launch pad. Like a living being, it is in some hesitation, trembling a little; for one or two seconds it hovers near the earth and suddenly, while leaving a stormy vortex of fire behind it, disappears. Only a bright firey trail can be seen in the sky.

Using a stopwatch the sports commissar notes the time of the spaceship's departure from the launch pad: "12 April 1961, 0907 Moscow time, Baykonur cosmodrome." Here and in the text which follows Moscow time is given. For the first time in the history of mankind a manned spaceflight began. The flier-cosmonaut Yuriy Alekseyevich Gagarin was in space aboard the "Vostok" satellite-ship.

Landing region. Here everything is ready for meeting of the cosmonaut on his native earth. A day prior to the launching the snow had piled up beginning in the morning, but toward midday it had thawed and the city streets had been transformed into rivers. The weather was unstable and this excited

everyone. But on 12 April, beginning with the morning, the sun was out like it was in spring. It seems that nature itself was joyful at the first flight of man into space.

All the means for communication and radioelectronic monitoring were in total readiness. The aircraft and helicopters of the search and evacuation group were in the air. The command point maintains continuous communication with them. At 0951 hours the automatic orientation system was switched on aboard the "Vostok" ship. At 1015 hours commands were sent to the ship for making preparations for descent. The braking engine was fired in an automatic cycle at 1025 hours.

Thirty minutes remained before the landing. The "Vostok" began to descend from orbit. After separation of the instrument compartment from the ship at 1035 hours the descent module of the "Vostok" ship entered into the dense layers of the atmosphere. Weightlessness began. The cosmonaut was subjected to an acceleration of 8 g. Through the window Yu. A. Gagarin sees how the flames roar around the ship. The temperature at the surface of the "Vostok" has attained several thousand degrees and in the ship's cabin it is +20°. The cosmonaut feels like the "Vostok" has begun to tremble. Twenty minutes remained before landing. The descent velocity is 220 m per second. Altitude is 7,000 m. Yuriy Alekseyevich felt a sharp jolt. It pressed him sharply to the seat. This was the opening of the braking parachute. At this time the hatch cover was shot off and two seconds later the parachute landing system was activated.

And now came the long-awaited instant: at 1055 hours USSR Flier-Cosmonaut Yu. A. Gagarin, having flown around the earth in the "Vostok" spaceship, after having implemented the flight program, landed in the stipulated region, 26 km to the northwest of the city of Engel's in Saratovskaya Oblast, near Smelovka village in Ternovskiy Rayon.

...Yuriy Gagarin looked at his wife and daughter, who looked at him with curiosity. The cosmonaut in his bright orange spacesuit headed for them. After taking off his space helmet, he cried to them: "Greetings, Comrades, Greetings!" At the same time, with the cry: "Yuriy Gagarin, Yuriy Gagarin!" workers ran up from the field machinery and surrounded him in a tight ring. The people embraced the hero, congratulating him on his great feat. They helped Gagarin to remove his spacesuit and someone gave him his service cap, with which he later did not part for a long time. In the company of the local inhabitants Gagarin approached the spaceship descent module and carefully examined it. At this time a helicopter with specialists from the search group approached accompanied by the sports commissar and motion picture operators. Everyone rushed to the spaceship, at which stood the smiling pioneer of space flights, citizen of the Soviet Union Yuriy Gagarin. Warm embraces and congratulations... These were happy minutes.

Although I knew that it was precisely he, cosmonaut No. 1 Yuriy Gagarin, who was before me, nevertheless, as required by the Sports Code, I aked him to show his identification card, noted the number and date of issuance, registered on a special blank the last name, first name, middle name, date and time of landing, checked the recognition symbols of the spaceship, on which was inscribed "Vostok USSR."

Here at the landing site we registered three first absolute world space records established on the legendary flight of Yuriy Alekseyevich Gagarin: record for flight duration (108 minutes), record for flight altitude (327.7 km) and record for the maximum load lifted to this altitude (4,725 kg).

In addition to the absolute world records for flight in space, Yuriy Gagarin established two all-union records for radio communication. They were also an international achievement: carrying out history's first two-directional radio communication "earth-space," "space-earth" in the short-wave range (9.019 MHz and 20.006 MHz).

...We returned to the spaceship, surrounded by local inhabitants, removed the spacesuit, ship's log, some instruments and belongings and returned to the helicopter. But it could be seen from the cosmonaut's face that he was fatigued. Everyone understood his state. After all, on the first space flight no one could give a guarantee of total safety. And only when you sense yourself back on your native earth, does one really become aware of what has occurred... Several minutes of flight and we are at the airport. Flowers, cries of "Hurrah!" "Hail to the world's first cosmonaut!." Gagarin raises his arms, smiles, sincerely takes leave of everyone, gets into the aircraft and suddenly stops and asks: "But where is the watch, that which I carried with me in space; it was sewed to the left sleeve of my spacesuit?"

The spacesuit was brought, the watch was cut off and Yuriy carefully placed it in his pocket... In the aircraft the physician V. G. Volovich again examined the cosmonaut. He checked the pulse, pressure, heart -- everything was in order, the feeling of well-being was excellent. Here we were photographed together with the cosmonaut. The aircraft takes course for the city of Kuybyshev where the cosmonaut was awaited by members of the State Commission, friends, correspondents and the residents of the large city on the Volga.

In the aircraft Gagarin eagerly ate fruits and drank grape juice. I said to him that three absolute world records had been set at the same time and asked how he had tolerated weightlessness.

"Weightlessness is a very interesting sensation. You raise your hand and it hangs in space until you apply the force to lower it. The notebook hovered in the air and floated until I caught it. Two-directional communication with the earth was a great support to the morale. I did

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not feel alone and was completely sure that the equipment would not fail."

On the next day a session of the State Commission was held at which we heard a report from the man who for the first time had been in space. He told about the operation of the ship's systems in flight, about everything which he had seen and experienced beyond the limits of the earth, in space orbit. It is difficult to forget these exciting days, especially those who had been direct witnesses of this outstanding event.

On the ship there were no technical failures and Yuriy Alekseyevich felt well. This first flight of man into space was carried out brilliantly. I remember the arguments which went on before the flight of Yu. A. Gagarin that specifically landing on the earth would delay man's flight into space for an indefinite time, that technology was still in no position to guarantee the safety of landing. So it was until by means of the satellite ships specialists had perfected return and landing on earth, preparing a reliable base for flight of the "Vostok-1" ship with the world's first cosmonaut Yuriy Gagarin.

Gagarin was the first to test a new level of velocities attained by engineering. We will recall how pronounced was the jump. At the beginning of our century steam locomotives whirled along on a par with the first automobiles and aircraft. Railroads even now are competing with automobile transport due to diesel, electric and gas-turbine engines. The speed of aircraft has increased extremely gradually, creeping up to the sound barrier, and with more than a little difficulty passed through it. Many years passed before aircraft began to fly twice and then three times more rapidly than the speed of sound. This is already the velocity of an artillery shell. But such an aircraft in comparison with a ship of the "Vostok" type is like a pedestrian in comparison with a whirling automobile. The space furrow plowed by the Soviet citizen Yuriy Gagarin in the virgin skies will forever remain in the memory of all mankind.

We frequently had the occasion to meet with Yu. A. Gagarin after his flight into space. Always I saw this remarkable man happy, filled with the joy of life, good, at the same time direct, principled and demanding.

For the first time I met him late in February 1961, that is, 1 1/2 months before his flight into space. It happened that I was visiting General Kamanin to ask about the impending flight of man into space. At this time several very young officers in air force uniforms were sitting behind the desk. Greeting the fliers, I heard the family names: Gagarin, Titov, Bykovskiy and Nikolayev. After an official meeting we had a friendly conversation about flights in jet aircraft under complex meteorological conditions and the further development of space technology. Then there was a discussion about flight work in the DOSAAF aeroclubs. The fact is that Yuriy Gagarin and Valeriy Bykovskiy in their times had graduated from these clubs, the first from the Saratov and the second from the Moscow

aeroclub of DOSAAF.

Together with Yu. A. Gagarin I had the occasion to be at the cosmodrome during the period of preparations for the next flight of the Soviet cosmonauts into space. The inhabitants of Baykonur always were glad to meet with this fascinating man, with his unforgettable and unduplicated smile. Here in the hours free from work he met with the children and spoke over local television. I observed his work during the period of training of the cosmonauts and the period of preparation of the entire launching complex for implementing the new flight program. Yuriy Alekseyevich intelligibly, competently and with love explained the design and construction of the spaceship or simply responded to any questions from whomever he was talking. Yuriy Gagarin was characterized by simplicity, spirituality and humanity. And it is no accident that hundreds of letters daily arrived at his address in which people not only asked him for some assistance, but also simply asked for advice. And he found the time to familiarize himself with each letter and answer it.

This remarkable Soviet man, blazing the way to the stars, will forever remain in the memory of all peoples of the earth.

The entire world has acknowledged Yu. A. Gagarin to be the first conquerer of space, establishing absolute world space records. He is the first cosmonaut awarded the Large Gold Medal by the IAF. Taking into account the exceptionally great services of USSR Flier-Cosmonaut Yu. A. Gagarin, the 61st General Conference of the International Aviation Federation held in London during the period 26-30 November 1968 unanimously adopted a resolution on establishing a gold medal named in honor of the first cosmonaut. Each year the IAF Council awards the Yu. A. Gagarin medal to the flier-cosmonaut who during the past year achieved the highest results in the field of man's conquest of space for peaceful purposes.

The 61st IAF General Conference, on the proposal of the delegation of the USSR Federation of Aviation Sports, also adopted a resolution establishing an International Day of Aviation and Cosmonautics, which beginning in 1968 is annually celebrated on 12 April, on the day of man's first flight into space, made by Yu. A. Gagarin.

The establishment of the Yu. A. Gagarin medal and the International Day of Aviation and Cosmonautics by the IAF is an international recognition of the outstanding successes of Soviet science in the investigation and study of space for peaceful purposes.

A Day in Space

In order to clarify the influence exerted on the human body by all space-flight factors (duration, weightlessness, accelerations, influence of cosmic radiation, etc.) and also to ascertain the combined operation of all on-board and ground equipment, it was decided to launch a man into space who would work there for 24 hours.

German Stepanovich Titov, together with the other cosmonauts, underwent the entire program of preparations for the impending flight. This program consisted of a combination of special tests and training sessions, diversified physical training and theoretical courses, including the fundamentals of rocket technology and space technology, design and construction of the "Vostok" spaceship, special courses in astronomy, geophysics and space medicine. In addition, for maintaining flight skills and checking himself under weightlessness conditions the cosmonaut carried out flights in aircraft and underwent other tests and training sessions for the stability of the vestibular apparatus.

The carrier-rocket with the "Vostok-2" spaceship, which carried the cosmonaut G. S. Titov, was launched from the Baykonur cosmodrome at 0900 hours on 6 August 1961. The ship weighed 4,731 kg; it was put into a circumterrestrial orbit with a perigee altitude of 178 km and an apogee altitude of 244 km. Immediately after the "Vostok-2" ship was put into orbit, G. S. Titov established communication with the earth through short-wave and ultrashort-wave channels. Weightlessness appeared. The cosmonaut then experienced the sensation that he was flying in an upside-down position. This sensation disappeared after 1 1/2 minutes.

At 1000 hours, as was provided for in the program specifications, G. S. Titov activated manual control of the ship. This experiment was carried out for the first time. German Titov told about this in his report: "After an hour of flight, cutting through the dark pitch-black night, I, as was required under the work plan, activated manual control of the ship. I admit that this was done not without internal excitement: after all, I was the first man in history who was to make a spaceship obey his commands. Would it obey the movements of my hands, I thought, and then resolutely placed by hand on the control panel. The 'Vostok-2' obeyed my wishes. It was easy to control the spaceship. It could be oriented in any desired position." Manual control of the ship was tested again on the seventh revolution. The manual orientation system of the 'Vostok' ship consists of an optical sight, a control stick for control of the three axes -- course, pitching and banking, sensors of angular velocity and other elements. This system includes orientation engines operating in an impulse regime.

By 2345 hours the "Vostok-2" ship had made ten revolutions around the earth and during this time had flown more than 410,000 km, a distance greater than the distance from the earth to the moon. During the course of the flight G. S. Titov took food: puré soup, meat and liver paté, processed cheese, different kinds of juices, and finally, bread. The food

was kept in soft tubes.

By 0600 hours on 7 August the "Vostok-2" had completed its 14th revolution around the earth. During this time vigorous preparations were being carried out in the computed landing region for meeting the cosmonaut on his native earth. When the "Vostok-2" began its 17th revolution, refined data began to arrive at the command point on the computed time and place of the landing. After implementing the flight program, at the end of the 17th revolution the automatic system for orientation and descent of the ship was activated. Then the instrument and descent compartments were separated. The descent module with the cosmonaut entered the dense layers of the atmosphere, accelerations appeared and finally the parachute system for the landing of the ship and cosmonaut came into play. After making the daylong flight, G. S. Titov safely landed by parachute at 1018 hours on 7 August 1961 near the village of Krasnyy Kut in Saratovskaya Oblast.

It was established as a result of processing of the data from orbital measurements carried out at the coordination-computation center that the distance of the flight of the "Vostok-2" spaceship with German Stepanovich Titov aboard was 703,143 km and the flight duration was 25 hours 11 minutes.

German Stepanovich Titov established absolute records: world records for the duration and range of space flight, world records for the duration and range of flight in the orbital flight class.

At a session of the International Astronautics Commission of the IAF on 12 March 1962 a decision was adopted to confirm the world records established by G. S. Titov:

-- flight range, 703,143 km;
-- flight duration, 25 hours 11 minutes.

Thus, new scientific-technical and sports achievements were entered into the IAF table. Soviet man had made still another important step in the conquest and study of space.

On this flight scientists for the first time raised the problem of studying the effect exerted on the human body by a state of weightlessness during prolonged flights. As is well known, K. E. Tsiolkovskiy had postulated that under weightlessness conditions man can experience different illusions and impairments in spatial orientation. Beginning from that time and until man's first flight into space a great many different kinds of hypotheses and opinions have been expressed. The flight of G. S. Titov was therefore of definite interest. During the orbital flight G. S. Titov developed unpleasant sensations which were characterized by him as a state close to motion sickness and expressed in dizziness and nausea. When the cosmonaut turned his head sharply the dizziness was intensified and there were illusions of the "floating" of objects. Not only the turning of the head, but also the flashing-by of objects ("running of the earth") caused unpleasant sensations.

However, despite all this, Titov did not give signs of spatial disorientation. This is attributable to the quite high indices of higher nervous activity and the strength of the cosmonaut's will.

The flight in the "Vostok-2" ship demonstrated that man fully retains his performance during long presence in space. Nevertheless, after the flight by G. S. Titov the system for training cosmonauts was reexamined to a considerable degree. In addition, at the suggestion of G. S. Titov scientists introduced some changes in the design of the "Vostok" ship.

First Group Flight

The next spaceship, the "Vostok-3," was launched on 11 August 1962 at 1130 hours. The ship was piloted by cosmonaut Andriyan Grigor'yevich Nikolayev. The ship weighed 4,722 kg and was put into an orbit around the earth with an apogee of 234.6 km and a perigee of 180.7 km.

After being put into orbit, A. G. Nikolayev proceeded to the implementation of the space flight program. And it was very complex, saturated with different kinds of investigations and experiments. Making revolution after revolution around our planet, the cosmonaut awaited the launching of his friend Pavel Romanovich Popovich. This happened a day later. At 1102 hours 33 seconds on 12 August 1962 the "Vostok-4" spaceship was launched with the cosmonaut P. R. Popovich. The ship was put into an orbit with an altitude at apogee of 236.7 km and an altitude at perigee of 179.8 km.

History's first group spaceflight of two manned satellite-ships, the "Vostok-3" and "Vostok-4," began. Here are the principal parameters of this group flight. The maximum altitude was: for the "Vostok-3" on the 17th revolution 229.8 km, for the "Vostok-4" on the first revolution 236.7 km. The minimum altitude was: on the 17th revolution, for the "Vostok-3," 178 km, for the "Vostok-4" on the first revolution, 179.8 km. The velocity of the satellite-spaceships during their passage through an orbital point with the maximum altitude above the earth's surface was: for the "Vostok-3" on the 17th revolution -- 7.81 km/sec, for the "Vostok-4" on the first revolution -- 7.82 km/sec. The minimum distance between them was 6.5 km. At this time the flight altitude over the earth's surface for the "Vostok-3" was 180 km, for the "Vostok-4" it was 184.5 km. This point was adopted as the beginning of the group (joint) flight. True, by this time the IAF had still not succeeded in formulating new regulations on the registry of group space flights. This problem was solved by the IAF only in March 1963.

During this joint flight the cosmonauts A. G. Nikolayev and P. R. Popovich were to carry out many different kinds of investigations and experiments related to solution of new biomedical and scientific-technical problems. These included: study of the influence of a prolonged space flight and especially the state of weightlessness on the principal physiological functions of man, clarification of the peculiarities of the course of the daily rhythm of physiological processes under conditions of prolonged orbital flight around the earth, evaluation of the psychological state,

performance of the cosmonauts in different flight segments, determination of the effectiveness of selection and training of cosmonauts, checking on the possibilities of the coordinated actions of the two crews in flight and the effectiveness of operation of all the construction elements of the spaceships, especially the life support systems. The successful performance of the task enabled designers, scientists and cosmonauts to solve long-range problems in increasing the duration of space flights, preparations for operations for the rendezvous and docking of ships, the creation of long-term orbital stations, etc.

As we know, the cosmonauts A. G. Nikolayev and P. R. Popovich in the course of the group flight in the "Vostok-3" and "Vostok-4" ships carried out checking of the operation of all on-board systems of the spacecraft, established radio communication with one another and with ground stations, carried out psychological, physiological and vestibular tests, carried out medical self-monitoring, registered the pulse and respiration rate, tolerance to accelerations, noise, vibrations and weightlessness, took food, oriented the ships in space with the use of manual control systems, made motion picture surveys, etc.

The second day of the flight had ended. The cosmonauts A. G. Nikolayev and P. R. Popovich made preparations for ending the group flight. On 14 August, together with the search team, we departed in helicopters for the landing site of the "Vostok-3" and "Vostok-4" ships. The weather was sunny and hot.

On 15 August 1962 a point appeared at an altitude of 7,000 m and over it -- the parachute canopy. I write in my notebook: "15 August 1962 at 0939 hours and 59 seconds the flier-cosmonaut A. G. Nikolayev separated from the 'Vostok-3' ship. He landed at 0952 hours in the neighborhood of Karkaralinsk city in Karagandinskaya Oblast. The satellite-ship 'Vostok-3' landed at 0944 hours 09 seconds in this same region."

At 0959 hours P. R. Popovich landed in the neighborhood of Atasu village in Karagandinskaya Oblast. Both cosmonauts, as well as the "Vostok-3" and "Vostok-4" ships, landed as provided for in the flight program, at a latitude of 48 degrees.

It was established as a result of processing of data at the coordination-computation center on the flight of the "Vostok-3" that the distance covered in space by this ship was 2,639,600 km, whereas the distance covered by the "Vostok-4" was 1,982,050 km. The flight of A. G. Nikolayev in the "Vostok-3" ship lasted 94 hours 09 minutes 59 seconds, whereas for P. R. Popovich it was 70 hours 43 minutes 48 seconds. The duration of the world's first group flight of the two Soviet flier-cosmonauts A. G. Nikolayev and P. R. Popovich in the satellite-ships "Vostok-3" and "Vostok-4" was 70 hours 23 minutes 38 seconds, and the distance covered in this flight was 1,975,200 km.

Thus, A. G. Nikolayev and P. R. Popovich established the first world records for the duration and distance of the group space flight in the class of orbital flights.

The group flight of A. G. Nikolayev and P. R. Popovich was deemed by the IAF to be an outstanding achievement in space conquest. The International Aviation Federation awarded the cosmonauts the "Kosmos" Gold Medal. The achievement of USSR Flier-Cosmonauts A. G. Nikolayev and P. R. Popovich demonstrated that it is possible to fly for a long time in spaceships of the "Vostok" type.

On this flight the cosmonauts A. G. Nikolayev and P. R. Popovich for the first time freed themselves from their harness, moved from their seats and were in a state of "free floating" (in a state of weightlessness): Andriyan Nikolayev for four periods for a total of 3.5 hours and Pavel Popovich for three periods lasting about three hours.

For the first time Soviet people and inhabitants of most of the countries of Europe, through the channels of Soviet television and through the "Intervideniye" system, observed the floating of cosmonauts within the ship and saw how both the cosmonauts carried out observations, maintained radio communication with the earth, and also performed orientation.

The group flight of the cosmonauts A. G. Nikolayev and P. R. Popovich in the "Vostok-3" and "Vostok-4" ships marked new roads for implementing still more complex and prolonged space flights.

Record Flight of the "Chayki"

The "Vostok-5" and "Vostok-6" spaceships were launched from Baykonur cosmodrome for further testing and improvement of the systems of manned spaceships and study of the influence of flight factors on the human body.

The "Vostok-5" spaceship, manned by flier-cosmonaut Valeriy Fedorovich Bykovskiy, was put into an orbit around the earth on 14 June 1963 at 14 hours 58 minutes 59 seconds. The orbital parameters of the "Vostok-5" ship were: perigee altitude 181 km, apogee altitude 222.1 km. The ship weighed 4,720 kg.

The "Vostok-6" spaceship was launched two days later, on 16 June, at 1229 hours 51 seconds. It was the first to be piloted by a woman -- Valentina Vladimirovna Tereshkova. The "Vostok-6" ship weighed 4,713 kg. It was put into an orbit around the earth with an altitude at perigee of 180.9 km and at apogee of 231.1 km. The period of revolution was 88.304 minutes.

The flight of the two spaceships of the "Vostok" type had as its purpose not only many technical problems, but also study of the influence of different spaceflight factors on the male and female body. The cosmonauts V. F. Bykovskiy and V. V. Tereshkova tolerated the accelerations and vibrations well. After shutting down the engines of the last stages of the

carrier-rockets and separation of the ships the cosmonauts experienced onset of a state of weightlessness. The flight mission included different kinds of work with the cabin equipment, the life support systems, and maintaining radio communication.

All the observations by the cosmonauts were entered into the log, registered on a magnetic recorder and photographed. Each day of the flight was scheduled for the cosmonauts. They slept at the prescribed time. After sleep they engaged in physical exercises and then ate breakfast. There were four meals a day and they consisted of natural foods. It must be said that during this joint flight of the two ships the more-than-a-little important problem of feeding of the cosmonauts was solved.

I recall the stories of Yuriy Gagarin and German Titov on how during the time of the flight they very carefully took the first swallows of water and sucked puré from tubes. The sandwiches which Andriyan Nikolayev and Pavel Popovich ate in space were already a victory. In the new flight the menu of the cosmonauts included veal, roast tongue, white and black bread, cutlets, and oranges. It has now become clear that even in a state of weightlessness cosmonauts can consume the most diversified kinds of terrestrial food during space flight.

During the time of the flight V. F. Bykovskiy and V. V. Tereshkova several times activated the ship's manual control. Radio communication played a major role in the flight mission. During the entire flight radiocommunication with the earth was stable and reliable on short and ultrashort waves.

The cosmonauts maintained radio exchange with one another. They coordinated their actions with one another by radio. They exchanged information on the operation of the instrumentation and compared the results of observations. Normal climatic conditions were maintained in the ship cabins during the entire flight: pressure, temperature, gas composition of the air. From the launching to the moment of landing all the systems and apparatus of the "Vostok-5" and "Vostok-6" ships operated faultlessly. The cosmonauts felt well. The joint flight of the "Vostok-5" and "Vostok-6" satellite ships continued for about three days.

The orientation system on the "Vostok-6" was switched on at the beginning of the 48th revolution on 19 June 1963. Then the braking engine was fired and the "Vostok-6" began to enter into the dense layers of the atmosphere. At an altitude of 6,500 m Valya was catapulted and two seconds later the parachute opened out.

Valentina Vladimirovna Tereshkova landed at 1120 hours on 19 June 1963 at a distance of 620 km to the northeast of Karaganda. I congratulated her with all my heart on the successful flight and the establishing of new

space records.

Later, at 1403 hours, at a distance of 540 km to the northwest of Karaganda, Valeriy Fedorovich Bykovskiy returned to earth. The duration of the flight of V. F. Bykovskiy was 118 hours 56 minutes 41 seconds and the distance covered was 3,325,957 km. During the three days of flight on the "Vostok-6" ship V. V. Tereshkova flew 70 hours 40 minutes 48 seconds and covered a distance of 1,970,990 km.

During the time of the space flights Valentina Vladimirovna and Valeriy Bykovskiy established eight new world records which the IAF registered as the next outstanding scientific-technical achievements of the Soviet Union in the exploration of space. For their feats in space the International Aviation Federation awarded medals and diplomas to the cosmonauts V. F. Bykovskiy and V. V. Tereshkova.

The space experiment carried out on the two satellite-ships "Vostok-5" and "Vostok-6" introduced a major contribution to the further development of cosmonautics. This joint flight ended the program of space investigations with ships of the "Vostok" series. In accordance with this program six manned "Vostok" ships with a total weight of 28,339 kg were put into circumterrestrial orbits. Soviet cosmonauts blazed 259 paths around the earth. They flew 381 hours 30 minutes 16 seconds and covered a distance of 10,662,740 km.

The successful implementation of the program for conquest and study of space by man in the "Vostok" satellite-ships enabled our scientists to proceed to flights in the "Voskhod" multiplace ships.

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"VOSKHOD" PROGRAM

Records of the First Space Crew

[Text] Only three and a half years have elapsed since the day of the first flight of the "Vostok" ship into space with a man aboard. And now it is 12 October 1964. The powerful carrier-rocket at 1030 hours 01 second carried the "Voskhod" multiplace spaceship, weighing 5,320 kg, upward from the launch pad. The ship carried a crew consisting of the ship's commander Vladimir Mikhaylovich Komarov, the science specialist Konstantin Petrovich Feoktistov and the physician Boris Borisovich Yegorov.

The new multiplace "Voskhod" spaceship consisted of a pressurized cabin (descent module) which carried the crew, the life support systems, supplies of food and water, means for monitoring and controlling the operation of the on-board systems of the ship, some of the radio equipment, television cameras, videocontrol apparatus, motion picture equipment, apparatus for medical and scientific investigations, and instrumentation for direction finding in the descent and landing segment. On the ship there was also an instrument compartment which held the radio equipment instruments, liquid-fuel engine, control apparatus, heat-regulating system and current sources. This compartment was pressurized.

On the outside of the instrument compartment there were cylinders with compressed gas and engines of the ship's orientation system, cylinders with compressed oxygen and air for ventilating the spacesuits and supplying the crew with oxygen in the event of accidental depressurization of the cabin, antenna systems for the ship's radio systems, and radiator of the heat-regulating system. At the time of return to the earth the instrument compartment is separated from the ship and burns up in the dense layers of the atmosphere. The ship carried a reserve solid-fuel braking engine duplicating the main braking engine. After the flight in orbit the pressurized cabin (descent module) together with the crew and the equipment is returned to earth.

For protection against the high temperatures in the descent segment, the pressurized cabin on the outer side had special thermal insulation. The cabin had three hatches. After landing the crew could emerge from the

cabin through any of these hatches. In addition, there were three windows in the cabin through which the crew could make visual observations and a motion picture survey. In the ship's cabin the crew sat in shock-absorbing seats which were molded to fit the cosmonaut's body.

The apparatus for manual control of flight and descent enabled the crew to orient the ship in space and to carry out a landing in the selected region using any of the available braking engines -- the main (liquid-fueled) or reserve (solid-fueled). For determining the direction of the flight and the local vertical during manual control the crew could use an optical orientation instrument or ion "erectors" of the ship's velocity vector.

The apparatus for automatic control of flight and descent made it possible in accordance with the stipulated program to carry out control of the onboard systems and the ship's orientation system in space and to bring about its landing in a stipulated region using the main (liquid-fuel) braking engine. At the time of automatic descent of the ship from orbit the axis of the engine is set on the sun by means of a photoelectronic solar sensor.

The ship carried radio apparatus for connecting the crew to ground stations during prelaunching preparations, in the sector when the vehicle is being put into orbit and during flight in orbit. In addition, the ship carried a magnetic recorder which could be activated either automatically from an oral signal or manually; a wide-band radio receiver; electroacoustic equipment; television system; apparatus for monitoring and registering the physiological functions of the crew in flight; radiotelemetric apparatus; system for the autonomous registry of data and sensors. In addition, the "Signal" radio system, operating at a frequency of 19.996 MHz, radio apparatus for monitoring the ship's orbit while the orbit is being formed, and apparatus for registering the doses of ionizing radiation were carried.

For maintaining the principal parameters of microclimate in the cabin within limits close to normal there was an air conditioning system ensuring the absorption of carbon dioxide and moisture and also releasing the necessary quantity of oxygen for breathing of the crew. The quantity of oxygen was regulated automatically. This was very important for the crew of the "Voskhod" ship, since in contrast to all the preceding flights V. M. Komarov, K. P. Feoktistov and B. B. Yegorov for the first time flew without spacesuits.

The ship's construction also included these systems: regulation of pressure and power, water supply, heat regulation, illumination of the cabin, and landing. The landing system ensured landing of the ship and its crew with a virtually zero vertical velocity.

Thus, with respect to design and equipment the "Voskhod" spaceship differed from the "Vostok" spaceship in that it was multiplace and supplied with a soft-landing system, it had a reserve braking engine, new instrumentation (additional orientation system with ion sensors, improved television and radioengineering equipment, etc.). As a result, the weight of the "Voskhod" ship was 589 kg greater than the weight of the "Vostok" ship.

On this flight the crew had to carry out a program diversified with respect to importance and content. Specifically: test the new multispace spaceship, investigate the performance of each crew member individually as a specialist in his branch of work, carry out biomedical, psychological and physical-technical investigations, study the influence of flight factors on the human body, etc. The crew had to carry out the entire program in the course of one day and after this carry out a landing.

The commander of the "Voskhod" ship V. M. Komarov carried out observations of the operation of all instruments and systems, manually oriented the ship, determined the time for orientation and damping of the ship after maneuvers, and monitored fuel expenditure. In addition, he carried out radio contacts with the earth, observed the earth's surface with different degrees of illumination, determined the light sensitivity of the eyes and the possibility for visual orientation, and also made entries in the ship's log and on the magnetic recorder.

The scientific specialist K. P. Feoktistov, together with the ship's commander, carried out radio communication with ground control stations and monitored the operation of equipment and on-board instrumentation. He also carried out astronomical orientation and control of the ship using ion sensors, compared the "Globus" and the on-board clock, carried out visual observations, photographed and made a motion picture survey of the horizon and the aureole of the earth's atmosphere, measured the brightness of the stars, carried out experiments with a fluid, etc.

The physician-cosmonaut B.B. Yegorov studied the functional state of the nervous system and the individual performance of each crew member in different stages in the space flight and investigated the influence of spaceflight factors on the functional state of the cardiovascular system and the blood system. He also studied external respiration, gas exchange and energy expenditures under weightlessness conditions, the functional state of the analyzer under weightlessness conditions, and monitored the operation of life support systems. Using a Frank needle, B. B. Yegorov took blood from his comrades for investigation, measured blood pressure, carried out functional tests with a dosed stimulus of the vestibular apparatus. He registered the bioelectric currents of the brain and the electric potentials arising during spontaneous and nonspontaneous eye movements. During the course of the entire flight B. B. Yegorov had no occasion to perform as a physician because all the crew members felt well.

It is true that in a state of weightlessness in the course of the orbital flight K. P. Feoktistov and B. B. Yegorov developed incorrect psychological concepts concerning "up" and "down." To one of them it seemed that he was in a semibent position with his face down, whereas to the other it seemed that he was upside down. The cosmonauts noted that the illusions appeared when they had their eyes open or closed. However, such a state did not interfere with them performing the flight program well. It should be noted that during the entire flight the crew commander flier-cosmonaut V. M. Komarov did not experience such phenomena.

By the morning of 13 October the crew of the "Voskhod" spaceship had completely implemented the planned program. Orbital data for the "Voskhod" ship arrived from the coordination-computation center. The minimum and maximum altitudes were 177.5 and 408 km respectively and the period of revolution was 90.087 minutes. The ship's velocity during transit through an orbital point at the minimum altitude above the earth's surface on the first revolution was 7.67 km per second and at the maximum altitude it was 7.39 km per second.

In the landing region everything was ready for the meeting of the ship and its crew. At 0955 hours 39 seconds the automatic orientation system was switched on aboard the "Voskhod" ship. At 1018 hours 58 seconds, that is, after 23 minutes 19 seconds, the braking engine was fired. At 1040 hours 30 seconds the ship's automatic landing system was activated. At 1047 hours 04 seconds the "Voskhod" ship with its crew aboard made a soft landing at a distance of 312 km to the northeast of Kustanay.

Still another space flight of a Soviet manned satellite-ship, the seventh, had been completed. Measurements indicated that the distance flown by the "Voskhod" was 669,784,027 km. The total duration of the flight was 24 hours 17 minutes 03 seconds. The crew of the "Voskhod" ship had established two absolute world records: maximum altitude of the space flight (408 km) and maximum mass (weight) (5,320 kg) carried to such an altitude and two world records: flight distance (669,784.027 km) and flight duration (24 hours 17 minutes 03 seconds) in the category of multiplace spaceships.

For carrying out the scientific-technical and biomedical investigations, having great practical importance for future manned space flights, as well as establishing world records, the crew of the multiplace "Voskhod" spaceship, consisting of V. M. Komarov, K. P. Feoktistov and B. B. Yegorov, was awarded the "Cosmos" Gold Medals and diplomas by the International Aviation Federation.

Man in Open Space

March 1965 was exceptionally cold and there was no indications of the onset of spring. Snow not only covered the sands of the desert, but also the structures of the entire launching complex. At the cosmodrome the crew

of the "Voskhod-2" spaceship made preparations for the storming of space.

On 18 March, at exactly 1000 hours, the "Voskhod-2" spaceship with a crew consisting of Pavel Ivanovich Belyayev and Aleksey Arkhipovich Leonov was launched. The ship was put into the stipulated orbit with the parameters: maximum altitude 497.7 km, minimum altitude 173.5 km, period of revolution 90.944 minutes; ship's velocity during transit through a point in the orbit with a maximum altitude above the earth's surface on the first revolution was 7.31 km/sec, with a minimum altitude -- 7.70 km/sec.

The "Voskhod-2" spaceship, like the "Voskhod-1," was a manned multiplace vehicle, but with some peculiarities of design. The ship also carried a transfer chamber for the emergence of the cosmonaut into space and his return to the ship. The chamber was connected to the cabin by a hatch with a tightly closing cover which was opened from inside the pressurized cabin both automatically by means of a special mechanism with an electric drive and manually. Drive control was accomplished from a control panel.

For the emergence of a cosmonaut into space there is a hatch in the upper part of the transfer chamber, having a hermetic cover, which also could be opened both automatically and manually. The transfer chamber holds two motion picture cameras for surveying the process of entry of the cosmonaut into the chamber and emergence from it, an illumination system, assemblies of the transfer chamber system. On the outside there is a motion picture camera for surveying a cosmonaut who is present in space, cylinders with a supply of air for filling the transfer chamber and cylinders with an emergency supply of oxygen.

A special spacesuit was developed for the emergence of the cosmonaut from the ship. It has a multilayer hermetic envelope by means of which excess pressure is maintained within the spacesuit, ensuring normal vital functioning of the cosmonaut. On the outside the spacesuit has a special covering for safeguarding the cosmonaut from the thermal effect of the sun's rays. These spacesuits were supplied to both crew members in order that the ship's commander in case of necessity could render assistance to the cosmonaut emerging into space.

The necessary survival conditions for cosmonauts when one of them emerges into space were ensured by a system for ventilation of the space suits and oxygen supply of the crew. In the event of cabin depressurization there is automatic switching to an oxygen supply and ventilation using the reserves of compressed oxygen and air present aboard the ship. The control of locking was accomplished by the ship's commander P. I. Belyayev from a panel installed in the cabin. In case of necessity the control of the principal locking operation could be performed by A. A. Leonov from a control panel set up in the transfer chamber. The spacesuit helmet has a double hermetic glass window and a protective filter which ensure the cosmonaut an adequate field of view and which safeguard the eyes against the influence of the sun's rays.

Prior to the flight P. I. Belyayev and A. A. Leonov were trained in spacesuits in an aircraft laboratory in which there was a model of the "Voskhod-2" with a transfer chamber. Here the cosmonauts "ran through" all the operations for emergence into space and return to the cabin. The training sessions were carried out under conditions of brief weightlessness during flight of the aircraft in a ballistic curve.

The "Voskhod" spaceship reached a maximum altitude of 497.7 km. This means that its crew established a world altitude record. Prior to this not one manned spacecraft had been at such an altitude.

As soon as the "Voskhod-2" began its free flight in space in the passive segment, A. A. Leonov, together with the ship's commander P. I. Belyayev, began to make preparations for an experiment for emergence into space.

The ship's transfer chamber was fully depressurized at the beginning of the second revolution at 1128 hours 13 seconds. At 1132 hours 54 seconds the hatch of the transfer chamber was opened and at 1134 hours 51 seconds the cosmonaut A. A. Leonov emerged from the transfer chamber into space. Man for the first time left his ship and was in open space.

Aleksey Leonov was connected to the ship by a line 5.35 m long. In the process of free floating Aleksey Leonov withdrew from the transfer chamber for the full length of the line. Pavel Belyayev, using a television camera and telemetry, monitored the work of his friend and was ready, if this was required, to render him the necessary assistance.

After carrying out a number of experiments, A. A. Leonov, at 1147 hours entered the ship's transfer chamber. And at 1151 hours 54 seconds, after the hatch was closed, began release of air into the transfer chamber. Thus, the flier-cosmonaut Aleksey Leonov was outside the ship under space conditions for 23 minutes 41 seconds. According to the provisions of the International Sports Code, the net time of man's presence in open space is calculated from the moment of his appearance from the transfer chamber (from the edge of the ship's emergence hatch) to his return into the chamber. Thus, A. A. Leonov was in open space outside the spaceship for 12 minutes 09 seconds.

After return to the cabin A. A. Leonov, together with P. I. Belyayev, continued to carry out experiments planned by the flight program. The cosmonauts carried out biomedical investigations, solved problems in space navigation, observed and studied the earth's atmosphere, etc.

At the end of the 18th revolution on 19 March 1965, commands for automatic descent of the ship were transmitted through radiotelemetric channels from the earth. But some malfunctions were discovered in the operation of the automatic orientation and landing system. This was reported to earth. After 30 seconds the ship was sent permission to use manual control. What strength,

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what self-control the ship commander P. I. Belyayev must have in order to make a correct and timely decision for descent! After all, all the operations for activating the landing systems were figured down to fractions of a second.

At 1119 hours 00 seconds P. I. Belyayev manually activated the orientation system and then fired the braking engine. At 1202 hours 17 seconds the "Voskhod-2" landed at a distance of 180 km to the northwest of Perm'. The ship descended in the taiga amidst high firs and deep snow.

The flier-cosmonaut A. A. Leonov, in a report on the flight on the "Voskhod-2" ship and on implementation of the experiment for emerging into space reported:

"Emergence from the ship was accomplished using a special locking system. The system was controlled from the cabin by the ship's commander. A special spacesuit and autonomous life support system ensured the safe execution of the experiment under conditions of a deep vacuum and during free floating in space."

"At the time of this experiment all the ship's systems for control of emergence and the autonomous spacesuit systems operated faultlessly. In the course of the experiment on the basis of final refined data I was in space for 23 minutes 41 seconds, including 12 minutes 9 seconds of free floating. Upon emergence into space and return to the ship I constantly maintained contact with the ship commander and also with the earth."

"Withdrawal from the ship was to a distance as much as 5.35 meters, the full length of the line. Free floating in space was accomplished in the course of several withdrawals and approaches to the ship. In the course of free floating I made observations and carried out experiments in accordance with the flight program. From space it is possible to observe clearly the earth's surface and horizon and scrutinize parts of the ship. The parts of the ship situated in the shadow were sufficiently clearly illuminated by the sun's rays reflected from the earth."

"My feeling of well-being when performing the experiment with emergence, when working in free space, during return to the ship, and also in the course of further flight was excellent. I was completely sure of the quality of the spaceship and did not question the reliability of the equipment and the life support systems."

Some of the conclusions are:

-- emergence from the ship into open space is entirely possible and now is nothing mysterious for man;

-- man in a special spacesuit with corresponding autonomous life support systems can not only exist in space, but also perform definite purposeful and coordinated operations;

-- work of a physical nature can be carried out in space and scientific observations can be made.

"After the flight I feel well. The state of the body remained the same as before the takeoff."

On 20 October 1965 the IAF approved a world record for the duration of man's presence in space outside a spaceship of 12 minutes 9 seconds established by the Soviet cosmonaut A. A. Leonov and the absolute record for maximum flight altitude for the "Voskhod-2" spaceship of 497.7 km established by the flier-cosmonauts P. I. Belyayev and A. A. Leonov. The IAF awarded Aleksey Leonov its highest award -- the "Kosmos" Gold Medal for history's first emergence of man into open space during flight of the "Voskhod-2" ship; USSR Flier-Cosmonaut P. I. Belyayev was awarded the IAF diploma and medal.

As a result of the daylong flight in the "Voskhod-2" ship P. I. Belyayev and A. A. Leonov covered a distance of 717,262.01 km and were present in space while aboard the ship for 26 hours 02 minutes and 17 seconds.

"SOYUZ" PROGRAM

"Soyuz-1" Ship in Orbit

[Text] The fundamental structural designs of the "Vostok" ship and then the "Voskhod" ship served as a basis for the designing and further improvement of spaceships of new types and classes.

At the time when spaceships of the "Voskhod" type were making their flights in orbits around the earth new, multiplace, more powerful manned spaceships had been created in the designs and calculations of engineers in the workshops of factories. These were spaceships which were given the name "Soyuz" and which were to be used in carrying out an extensive complex of investigations in circumterrestrial space and in work for docking and creating permanent orbital stations. The appearance of the "Soyuz" spaceships marks a new stage in the development of manned space vehicles.

With respect to design specifications, the "Soyuz" ship differs greatly from its "brothers" in the exploration of the universe -- the "Vostok" and the "Voskhod." Instead of the two compartments, such as in the "Vostok" and "Voskhod," the "Soyuz" consists of three principal compartments: descent, orbital and instrument-assembly.

The orbital compartment is used in carrying out scientific investigations, emergence into space, as a place for work, sleep and rest of the cosmonauts. In addition to communications apparatus, here there is an all-wavelength radio receiver for listening to transmissions of surface radio broadcasting stations; a special "servant" for the placement of scientific instrumentation, a pharmacy, hygiene objects, etc. The orbital compartment can be used as a transfer chamber for man's emergence into space. In this case provision is made for both automatic and manual exhaustion of gases and ventilation of the compartment. The hatch for emergence into space is opened either automatically or manually.

The descent compartment (cabin for the cosmonauts) is intended for holding the crew when they are being put into orbit or during their return to the earth. The heat-shielding cover safeguards the body of the descent module

from intensive aerodynamic heating during descent to the earth. It has such a configuration that it ensures controllable descent using aerodynamic quality. The descent module holds the seats for the cosmonauts, the ship's control panel, the descent control system, radio communication and life support systems and the parachute system.

Normal terrestrial conditions (pressure, gas composition, temperature, humidity) are maintained in the ship's cabin by means of heat regulation and regeneration. The cabin holds containers with reserves of food and water. While in flight the crew can wear ordinary clothing, dispensing with spacesuits. The body of the descent module is the site of attachment of the jet engines, which are used for control of the descent and a soft landing. By means of rotating of the descent module with respect to banking angle it is possible to change the magnitude and direction of the lift, which reduces the accelerations to 3-4 g and substantially increases the landing accuracy. The orbital compartment and the cosmonaut cabin communicate with one another by means of a sealed (hermetic) hatch. The total volume of these two compartments is nine cubic meters.

The instrument-assembly compartment holds the assemblies of the heat-regulating system, radio communication equipment and radiotelemetry apparatus, power supply system, orientation system instruments and apparatus for the control of motion with computers and engines for ensuring maneuvers in orbit. Installed in the tail part of the ship in the instrument-assembly compartment there are panels of solar cells with a useful area of about 14 square meters.

The equipment of the "Soyuz" spaceship completely ensures its autonomous flight and pilotage and the engines make it possible to carry out maneuvers to an altitude of 1,300 km.

One of the principal systems of the "Soyuz" ship is a system for orientation and control of motion. By means of this system, in the course of the flight the ship is oriented both automatically and manually; it is controlled thus during approach, tie-up and docking. This system includes ion, IR and optical orientation systems, the cosmonaut's optical orientation sight, gyroscopic instruments and electronic computer control units, radioelectronic apparatus for search and guidance, a system of actuating elements -- low-thrust engines and two ship control sticks. One stick is for the control of linear movements of the ship and the other is for the control of turns.

With approach to another flightcraft the cosmonaut uses the optical sight and television cameras for observation. The radioelectronic apparatus for the "Soyuz" ship ensures the reception of commands from the earth, two-directional radiotelephonic and telegraphic communication, determination of orbital parameters, and transmission of a TV image of conditions inside and outside the ship to the earth.

The "Soyuz" spaceships had a docking system. Using the "Soyuz" ships it is possible to make flights up to 30 days. Their design ensures the safety of a crew against solar radiation.

The "Soyuz" spaceships underwent careful ground tests in laboratory, stand, and flight conditions for resistance to vibration, thermal shielding, airtightness and different landing conditions. Tests were made of the separation of the orbital compartment and descent module, opening of the antennas and solar cells, and operation of the landing systems.

Testing of the "Soyuz-1" spaceship was assigned to Hero of the Soviet Union USSR Flier-Cosmonaut Lt. Colonel-Engineer Vladimir Mikhaylovich Komarov. This modest, forceful and courageous man in October 1964, together with Konstantin Feoktistov and Boris Yegorov, passed a hard test during flight in the "Voskhod" ship.

When the State Commission approved Vladimir Komarov as ship commander for the "Soyuz-1." Yuriy Gagarin told about it: "In my opinion, it was very good that the performance of such a complex task was delegated specifically to Komarov. The choice was very apt. He is a beautifully educated, well-trained cosmonaut. It must be emphasized that he will implement the program not simply as a flier-cosmonaut, but as a man who in several years had become a specialist in his business. The space engineer assignment had become a profession for him. Such a detail is very important if one takes into account the nature of the present task."

23 April 1967. Baykonur cosmodrome. 0100 hours. The carrier-rocket with the "Soyuz-1" spaceship, illuminated on all sides by searchlights, majestically stands on the launch pad. Thirty minutes later a bus delivers V. M. Komarov to the rocket. An elevator carries the cosmonaut to the top of the rocket, to the ship. Prelaunching readiness is announced.

At precisely 0335 hours on 23 April 1967 the rocket is launched, carrying with it the "Soyuz-1" ship. A few minutes elapse and the "Soyuz-1" has been put into a space orbit with a period of revolution of 88.6 minutes, a maximum altitude of 224 km, a minimum altitude of 201 km. The test flight has begun.

Vladimir Komarov thoroughly reports to the control point concerning the operation of the ship's systems, about his feeling of well-being and the results of observations carried out in space. The cosmonaut's voice is calm and reasoning. He concisely, precisely, clearly and specifically answers the questions from the earth. With complete responsibility V. M. Komarov understands that this flight is a highly complex test experiment. And any new experiment, the first steps into the unknown, is difficult, stressed and dangerous work which requires from the test pilot a great effort of the will, self-composure, self-command. The flight program approached completion. From Baykonur cosmodrome we took off in an IL-18 aircraft for the landing region. The search team was in complete readiness

for meeting the cosmonaut on his native earth. In helicopters we fly to the computed landing site of the "Soyuz-1" ship.

On 24 April, toward the end of the daylong flight, V. M. Komarov was sent commands for suspending further flight. Over the Africa region coded commands for descent arrived aboard the ship through radiotelemetric channels, being received in the time-programming unit. At precisely the stipulated time the ship's orientation system was switched on. After this the braking engine was fired. Velocity began to decrease. The "Soyuz-1" began to descend from orbit.

After some time the compartments were separated. Vladimir Komarov reported that everything was proceeding normally. These were his last words. The descent module entered the dense layers of the atmosphere at the rigorously determined time and in the stipulated corridor. We all awaited the landing of the cosmonaut with impatience.

But the unexpected occurred. At an altitude of seven kilometers the canopy of the main parachute failed to open; it should have extinguished the velocity of failing (it was 220 m/sec -- about 800 km/hour).

USSR Flier-Cosmonaut Hero of the Soviet Union Vladimir Mikhaylovich Komarov died tragically.

We lost a remarkable man, a courageous test pilot and excellent comrade. This was a severe loss for everyone living on our planet. Vladimir Mikhaylovich Komarov by his flights into space in the "Voskhod" and "Soyuz" ships made an inestimable contribution to the further development and improvement of space technology. Mankind will forever retain his glorious name in the annals of space conquest.

New Experiments in Space

After carrying out the experiment associated with man's emergence from the ship into space, the next order of business was the matter of rendezvous and connection of spaceships in space, that is, docking. This task was brilliantly performed by Soviet scientists using automatic satellites. On 30 October 1967 the two artificial earth satellites "Kosmos-186" and "Kosmos-188" for the first time in the entire history of exploration of the universe, by means of special engines and a wnole complex of radioelectronic apparatus and computers approached one another, docked automatically and after this began free flight in space at an altitude of 276 km. In a docked state the "Kosmos-186" and "Kosmos-188" satellites continued their flight for three hours thirty minutes. By command from the earth the artificial satellites were automatically undocked. After some time the satellites returned to earth.

On 15 April 1968 the second automatic docking of satellites, "Kosmos-212" and "Kosmos-213," took place on Soviet initiative. They were in a docked state for a period of three hours fifty minutes.

Man's first emergence into space and the implementation of automatic docking of spacecraft in orbit gave a new impulse to solution of some problems in the long-range development of space biology and medicine and the use of multipurpose flightcraft.

The flight of man into space was complex and dangerous, despite the fact that there was more than a little experience in this field. Here the problem arises of the interaction between man and a flightcraft. The vigorous development of automatic systems, automatic instruments and apparatus does not mean that man will not fly and control the flight of the ship, however complex and prolonged it may be. No automatic system or instrument can completely replace man in carrying out some operations both on earth and in space.

In this connection G. T. Beregovoy, the future pilot of the "Soyuz-3" ship, even before the flight was asked by correspondents: "Recently the voice of engineers have been raised in an attempt to reduce man to an appendage of automatic apparatus, to an assistant of an all-knowing automatic system. What do you think of this?"

"Academician Korolev gave automation its due," stated Beregovoy, "but insistently required that under spaceflight conditions the flier must control the apparatus. The psychological factor must also be taken into account. Man feels more confident when he knows that the success of an experiment is dependent on him. It seems to me that the flight of Pavel Belyayev and Aleksey Leonov on the 'Voskhod-2' ship speaks out for the 'rights' of man in space. As is well known, the ship's commander in the final stage of the flight used manual control for landing. A second example. Aleksey Leonov tested the transfer chamber [lock system] for emergence into space and tried out an unusual spacesuit. In the immediate future man must have the know-how and ability to work outside a ship, be able to carry out terrestrial work in space. Konstantin Eduardovich Tsiolkovskiy wrote about this in his time and Sergey Pavlovich Korolev has said much about this. Workers and specialists must participate in the assembly and repair of space stations and therefore emergence from the ship and transfer from one ship to another will become an ordinary undertaking. For the time being it is necessary to test the space apparatus stage-by-stage as it is put at the disposition of cosmonauts of tomorrow. A difficult but worthy task stands before the testers of the new space apparatus. Now this is the purpose of my life."

We can easily become convinced of this by familiarizing ourselves with the subsequent flights of the "Soyuz" spaceships. Together with Vladimir Komarov, Hero of the Soviet Union Georgiy Beregovoy and other cosmonauts were prepared for the flight in the "Soyuz" spaceships and carrying out

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new experiments. They underwent a whole series of special tests and training sessions. The new flight program required high technical, special theoretical and also diversified general physical training. The cosmonauts G. T. Beregovoy, V. A. Shatalov, B. V. Volynov, A. S. Yeliseyev and Ye. V. Khrunov flew a great deal in aircraft under weightlessness conditions, underwent training sessions in a model of the "Soyuz" ship cabin on a special trainer and in an aircraft, over a long period of time were in a special soundproof chamber, trained on a centrifuge and made parachute jumps from aircraft.

The cosmonaut must thoroughly know his ship, all the instruments and equipment, must be able to deal with them under any conditions which may arise during flight. For these purposes the cosmonauts began to study the ship in the factory workshop, in the process of its creation, and then during stand and preflight tests. They were active participants in discussing the design and layout of the ship and its testing. During training sessions they developed skills in controlling the ship systems and in carrying out specific operations provided for in the program of the impending flight.

The "Soyuz" training ship or models of the compartments were installed in a special aircraft and raised into the air together with the flier-cosmonauts. In multihour flights the cosmonauts A. S. Yeliseyev and Ye. V. Khrunov while in a state of weightlessness tested the method for transfer in spacesuits from one ship to another and carried out other experiments planned by the impending flight program.

Then training sessions were carried out in pressure chambers and in a deep vacuum, that is, under conditions close to the conditions in spaceflight. Here the real systems of the ship were installed and the cosmonauts checked the air lock system while wearing spacesuits, using individual life support means; they also underwent different kinds of training programs. In addition, the cosmonauts also underwent various kinds of biomedical training.

At the time when the cosmonauts ended preparations for future launchings into space, the spaceships "Soyuz-2" and "Soyuz-3" were already ready for launching in the factory workshops. The first of these was an unmanned automatic satellite ship and the second was a manned satellite ship in which G. T. Beregovoy was to make a flight.

The "Soyuz-2" spaceship was launched on 25 October 1968 at 1200 hours. The ship was put into an orbit with the parameters: period of revolution -- 88.5 minutes, maximum distance from the earth -- 224 kilometers, minimum distance -- 186 kilometers, orbital inclination -- 51.7 degrees.

On 26 October 1968 at 1134 hours the "Soyuz-3" spaceship was launched from Baykonur cosmodrome; it carried the cosmonaut G. T. Beregovoy. He was put into an orbit with a maximum altitude of 254.5 km, a minimum altitude of 205 km and a period of revolution of 88.6 minutes. At this time the "Soyuz-2" flew over Baykonur.

G. T. Beregovoy immediately proceeded to implementation of the flight mission. After separation of the last stage of the carrier-rocket the "Soyuz-3" was in the rendezvous zone. On the first revolution around the earth the "Soyuz-3" ship made maneuvers for approach with the "Soyuz-2" ship. The ships approached to a distance of 200 m. Then, using the manual control system, the cosmonaut moved the "Soyuz-3" ship to the "Soyuz-2" to within a distance of several meters. On 27 October the maneuvering and approach of the ships was accomplished repeatedly both automatically and manually. On 28 October 1968 at 1051 hours the "Soyuz-2" ship, by command from the earth, made a soft landing, and on 30 October, upon terminating the entire program, the "Soyuz-3" ship at 1025 hours with the flier-cosmonaut Beregovoy made a landing 70 km to the north of the city of Karaganda. The results of this flight confirmed the good maneuverability of the ship, its great reliability and the high effectiveness of the work of both automatic and manual control. In addition, G. T. Beregovoy carried out a series of scientific investigations and observations which are of unquestionable interest for science. The duration of the flight of G. T. Beregovoy in the "Soyuz-3" ship was 94 hours 51 minutes and the distance covered was 2,680,000 km. The "Soyuz-3" ship weighed 6,575 kg.

The International Aviation Federation registered this weight as an absolute world record for the maximum mass of a ship raised to the altitude of orbital flight.

For carrying out the broad complex of scientific-technical and biomedical investigations which are of practical importance for the further conquest of space, the IAF awarded USSR Flier-Cosmonaut, twice Hero of the Soviet Union Georgiy Timofeyevich Beregovoy the Yu. A. Gagarin Gold Medal.

The cosmonaut received this high award at the IAF General Conference whose regular session was held in Helsinki in 1969.

Early in 1969 in our country plans were laid for carrying out a more complex experiment in space using the two manned spaceships "Soyuz-4" and "Soyuz-5." In accordance with the program the ships should dock in space and create the world's first experimental space station. In the course of the flight the two cosmonauts had to transfer from one ship to the other.

On 14 January 1969 at 1039 hours the "Soyuz-14" spaceship was launched from the Baykonur cosmodrome. It was manned by Flier-Cosmonaut V. A. Shatalov. The perigee altitude was 173 km, apogee was 225 km. After orbital correction on the fourth revolution the perigee altitude was 207 km, apogee was 254.8 km.

The crew of the "Soyuz-5" ship, consisting of the ship's commander B. V. Volynov, ship's engineer A. S. Yeliseyev and engineer-researcher Ye. V. Khrunov was launched from the Baykonur cosmodrome at 1414 hours on 15 January 1969.

At the time of the launching of the "Soyuz-5" ship at 1000 hours, the "Soyuz-4" ship, manned by V. A. Shatalov, passed over the Baykonur region. Cosmonaut Shatalov could clearly see the launching of the new ship through the windows. When the "Soyuz-5" ship with the crew aboard was put into an orbit with a maximum altitude of 253.4 km and a minimum of 200 km the group flight began.

The commanders of the "Soyuz-4" and "Soyuz-5" ships reported that the implementation of the program of joint experiments had begun. A direct television transmission began from space. On the morning of 16 January the crews of the ships received permission to carry out the experiment. First the ships carried out maneuvering for the purpose of automatic approach. Then the on-board radar search and guidance system was switched on; this ensured their automatic approach.

For this purpose the "Soyuz-4" spaceship was supplied with an "active" docking system and the "Soyuz-5" had a "passive" docking system. After some time the approach of the active ship to the passive ship began. The distance between the ships was only 100 m. The "Soyuz-4" commander V. A. Shatalov took over control. He controlled the operation of the on-board jet engines and carried out ship orientation for more precise approach and docking with the "Soyuz-5" ship. V. A. Shatalov reported that a distance of 40, and then 20 meters, remained to the "Soyuz-5" ship. Finally the long-awaited moment arrived. At 1120 hours on 16 January 1969 there was a space docking of the two manned spaceships "Soyuz-4" and "Soyuz-5."

Thus, the world's first experimental station began to function in an earth orbit. It consisted of two cosmonaut cabins, two orbital compartments for scientific research and rest of the cosmonauts and two instrument-assembly compartments with a total useful volume of 18 cubic meters. The space station weighed 12,924 kg.

The next important experiment on this flight was the emergence of Yevgeniy Khrunov and Aleksey Yeliseyev into open space and their transfer to the "Soyuz-4" ship.

The cosmonauts Yevgeniy Khrunov and Aleksey Yeliseyev donned spacesuits in the orbital compartment with the assistance of Boris Volynov. After this Volynov passed into the crew's compartment, closed the hatch behind him and lowered the pressure in the orbital compartment. Then the exit hatch was opened. The first to emerge from it was Khrunov, and after him -- Yeliseyev. The cosmonauts inspected the station and carried out scientific experiments. At this time Vladimir Shatalov had already opened the entrance hatch in the second orbital compartment; he encountered his friends and helped them to remove their spacesuits.

The space orbital station continued its flight until 1555 hours on 16 January and at this time there was an undocking of the "Soyuz-4" and "Soyuz-5" ships.

The "Soyuz-4" ship with the cosmonauts V. A. Shatalov, Ye. V. Khrunov and A. S. Yeliseyev landed on 17 January at 0953 hours. The "Soyuz-5" ship with the cosmonaut B. V. Volynov landed on 18 January. The cosmonauts Yevgeniy Khrunov and Aleksey Yeliseyev were simultaneously outside the ship in open space for 37 minutes. They spent about one hour in the space vacuum.

The International Aviation Federation placed a high evaluation on the feat of the Soviet flier-cosmonauts V. A. Shatalov, B. V. Volynov, Ye. V. Khrunov and A. S. Yeliseyev. For outstanding scientific-technical achievements and for establishing absolute world records as a result of the flights of the "Soyuz-4" and "Soyuz-5" they were awarded the IAF "USSR Flier-Cosmonaut V. M. Komarov Diploma" and the De la Vaulx medals.

On this flight the Soviet cosmonauts established absolute world records for the maximum total weight of the "Soyuz-4" and "Soyuz-5" ships in a docked state (total station weight 12,924 kg), the flight duration of these ships in a docked state — 4 hours 33 minutes 49 seconds and the simultaneous presence of two cosmonauts (Ye. Khrunov and A. Yeliseyev) in open space — 37 minutes. The experimental results of flights of the "Soyuz-4" and "Soyuz-5" determined a new stage in the development of space research.

The Soviet flier-cosmonauts made a flight in space in the more powerful and perfect spaceships of the "Soyuz" type. We once again were convinced that space technology is ageing more rapidly than those who are creating it. Replacing the old ships, which have already found their place in museums and pavilions of exhibitions, new ships are appearing which are intended for carrying out more complex scientific and technical tasks for man's planned conquest of space.

The implementation of the important scientific and technical experiment with the "Soyuz-4" and "Soyuz-5" ships is one of the beacons or milestones on the way to further space conquest. The docking of the ships was carried out when performing very complex technical problems: distant approach (to a distance of 100 m from the passive ship); near approach, as a result of which the active ship must occupy a definite position relative to the docking unit and the passive ship; and then — mechanical joining of the ships, their rigid drawing together and the connection of electric circuits.

For carrying out all the operations for docking of the two space objects in space the on-board and ground radioelectronic and optical apparatus are of great importance, as well as computers and other equipment in the control system. For example, the longitudinal component of velocity must be in the range from 0.08 to 0.5 m per second, the transverse velocity component — 0.3 m per second, the mismatch angle for the axes of the vehicles must be not more than 10°, whereas the lateral linear displacement must not exceed 0.5 m.

The implementation of the world's first docking of two spaceships, the creation of the world's first experimental space station and the carrying out of the simultaneous transfer of two cosmonauts from one ship to another are of enormous scientific importance for carrying out all possible operations in space, primarily in the assembly and servicing of large orbital and interplanetary automatic stations, fueling, delivery of food supplies, repair of ships, rescue and exchange of flightcraft crew members, rendering of technical and medical assistance, etc.

The new achievements in space became possible due to the self-sacrificing work of Soviet scientists and engineers, the clever and precise work of our production workers, due to the fatherly concern of the Communist Party and the Soviet government. And these successes are a guarantee that our cosmonauts will be able to perform new feats in the conquest of the universe in the interests of all mankind.

October Launchings

Prior to flight into space on the standardized "Soyuz" spaceships everone made preparations, ranging from the designers, scientists, engineers, technicians and cosmodrome workers and ranging through the workers at the plant. On the three "Soyuz" manned ships the group of flier-cosmonauts and experimental engineers were assigned the task of carrying out extensive scientific and technical work. For the first time the crews were to test methods for simultaneous control of ships and testing different methods for the welding of metals under conditions of a space vacuum and weightlessness. The program provided for the testing of on-board systems and the construction of improved flightcraft, carrying out further checking of manual control systems, checking apparatus and methods for autonomous control, carrying out the relative maneuvering of ships in orbit, etc.

On 11 October 1969 the "Soyuz-6" ship with a crew aboard was launched into space at 1410 hours: ship commander Georgiy Stepanovich Shonin and ship's engineer Valeriy Nikolayevich Kubasov. The orbital perigee altitude was 186.1 km, apogee altitude was 255.7 km and the period of revolution was 88.361 minutes. The ship weighed 6,577 kg.

After being put into orbit the crew performed manual orientation of the ship, checked the operation of all systems and proceeded to implementation of the flight program. After some time Georgiy Shonin and Valeriy Kubasov successfully carried out a series of medical experiments, made observations and photographed the earth's surface. At 1039 hours on 12 October, when the "Soyuz-6" had completed its 14th revolution, the cosmonauts performed autonomous navigation and determined the ship's parameters and its position.

The "Soyuz-7" spaceship was put into an earth orbit from Baykonur cosmodrome at 1344 hours 42 seconds on 12 October 1969. The crew consisted of three men: ship commander Anatoliy Vasil'yevich Filipchenko, ship's engineer Vladislav Nikolayevich Volkov, and engineer-researcher Viktor Vasil'yevich Gorbatko.

The orbital parameters of the "Soyuz-7" ship were: maximum altitude -- 237.4 km, minimum altitude -- 207.4 km, period of revolution -- 88.634 minutes. The ship weighed 6,570 kg.

Thus began the group flight of the two spaceships. The "Soyuz-6" and "Soyuz-7" crews carried out manual orientation, turning, experiments with joint maneuvering in orbit, medical monitoring, establishing radio communication through the "space-space," "space-earth" and "earth-space" channels.

By 1020 hours on 13 October the "Soyuz-6" ship had made 30 revolutions and the "Soyuz-7" had made 14 revolutions around the earth.

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The "Soyuz-8" spaceship was launched on 13 October 1969 at 1329 hours and 09 seconds. The crew consisted of the ship commander Vladimir Aleksandrovich Shatalov and ship's engineer Aleksey Stanislavovich Yeliseyev. The "Soyuz-8" was put into an orbit with the parameters: maximum altitude — 292.3 km, minimum altitude — 205.5 km, period of revolution — 88.610 minutes. The ship weighed 6,646 kg. As is well known, in January 1969 V. A. Shatalov and A. S. Yeliseyev participated in a group flight in the ships "Soyuz-4" and "Soyuz-5."

History's first conquest of space by a group flight of three spaceships with a total complement of seven men began when the "Soyuz-8" ship was put into the stipulated orbit. The crews of the "Soyuz-6, -7, -8" spaceships had to carry out a number of technical and scientific research tasks: maneuvering of the three ships in orbit with the use of manual control and approach during relative orientation, maintenance of a stipulated orientation in order to ensure implementation of other technical and scientific experiments. The program provided for carrying out welding work in open space for the purpose of investigating the peculiarities of welding by different methods. In addition, the crews had to test autonomous navigation methods, carry out monitoring of operation of on-board systems, test different on-board instruments, carry out radio communication with the earth and between ships, make television reports, etc.

By 1330 hours on 14 October the "Soyuz-6, -7, -8" ships had already been in group flight for more than a day. During this time the cosmonauts, in addition to scientific and technical experiments, carried out a number of important biomedical investigations for the purpose of studying the influence of spaceflight factors on the human body. The crews checked out the techniques for piloting the ships in orbit. On 15 October the "Soyuz-7" and "Soyuz-8" ships approached to a distance of 500 m and the cosmonauts visually observed one another. All the approach maneuvers were registered by the crew of the "Soyuz-6" spaceship. The approach of the "Soyuz-7" and "Soyuz-8" crews during the entire joint flight was carried out repeatedly.

On the 77th revolution on 16 October the cosmonauts G. S. Shonin and V. N. Kubasov carried out a unique experiment with welding in space. Here is what was said about this by the ship's engineer V. N. Kubasov of the "Soyuz-6," who had personally carried out this experiment: "An autonomous welding apparatus, the 'Vulkan,' weighing about 50 kg, was created for carrying out welding in space. This apparatus was designed for automatic welding by three methods: with a compressed arc (with low-temperature plasma), with an electron beam and with a melting electrode. The 'Vulkan' welding unit was mounted in the orbital compartment of the 'Soyuz-6' ship and the remote control panel was placed in the ship's cabin. Prior to the onset of welding this compartment was depressurized. After some time I activated the welding apparatus, successively employing all three welding methods. Welding was checked in the ship using a light tableau and also on earth on the basis of telemetric data. After completing the experiment the orbital compartment

was depressurized and the pressure in it was brought into equilibrium with the pressure in the descent module. The hatch opening was opened and we moved into the orbital compartment. Then the 'Vulkan' apparatus table was demounted and together with the samples was carried from the orbital compartment into the descent module. The experiments demonstrated the fundamental possibility of the welding of metals by melting under conditions of weightlessness and a vacuum in space. The experiment with welding under space conditions, which was successfully carried out, affords further prospects for carrying out construction and assembly work in space."

After successful implementation of the flight program the "Soyuz-6" spaceship with the cosmonauts G. S. Shonin and V. N. Kubasov at 1152 hours and 47 seconds on 16 October 1969 landed 180 km to the northwest of Karaganda. During five days of continuous presence in space aboard the "Soyuz-6" ship G. S. Shonin and V. N. Kubasov flew together 117 hours 41 minutes 47 seconds and covered a distance of 3,217,780 km.

By this time the "Soyuz-7" and "Soyuz-8" spaceships had completed their 67th and 51st revolutions around the earth respectively. The crews of the "Soyuz-7" and "Soyuz-8" ships continued to carry out scientific-technical and biomedical research.

The "Soyuz-7" spaceship with a crew consisting of A. V. Filipchenko, V. N. Volkov and V. V. Gorbatko at 1125 hours and 10 seconds on 17 October 1969 landed 155 km to the northwest of the city of Karaganda.

A day later, that is, on 18 October 1969 at 1109 hours and 59 seconds the "Soyuz-8" spaceship, manned by the ship group commander Hero of the Soviet Union, USSR Flier-Cosmonaut V. A. Shatalov and ship's engineer Hero of the Soviet Union A. S. Yeliseyev, landed 145 km to the north of the city of Karaganda.

Over a period of seven days the crews of the three Soviet "Soyuz" spaceships carried out more than 300 maneuvers in orbit, checking out the techniques used in autonomous navigation and for interaction with the ground command and measurement complex. They carried out an extensive volume of scientific investigations and observations and carried out important geological and geographic studies. The successful experiment in welding metals under conditions of weightlessness and a space vacuum was of great importance for space technology.

Almost every manned flight of spaceships brings new record achievements. The checking, registry and certification of these attainments is the responsibility of the International Aeronautical Federation. As we have already mentioned, this organization arose in the course of development of aviation technology and its work to some degree stimulated setting of new records for speed, altitude, flight range and load-lifting capacity of aircraft.

The activity of the IAF is of great importance in our day as well, although the setting of records in space is not in itself the purpose of space flights.

Even the first steps in cosmonautics greatly exceeded the successes in aviation achieved during the decades of its development. The first Soviet satellite attained a velocity of about 8 km per second. The load-lifting capacity of modern carrier-rockets is many hundreds of tons. Spacecraft have overcome the barriers of first and second cosmic velocities, have reached the neighborhoods of Mars and Venus, and have become artificial solar satellites. The distances on space flights are hundreds of millions of kilometers.

Manned space flights occupy a special place in the considerably broadening sphere of activity of the IAF. And this is not accidental. Precisely this field of spece technology requires an especially great reliability of the rocket-space systems, the design of spaceships and life support systems. Many problems, only recently seemingly insoluble, are now being successfully overcome.

What spaceflight factors exert an influence on the duration of manned flights? We recall that the first flight of man -- that of Yuriy Gagarin -- lasted about 108 minutes. However, this single revolution around the earth opened the road into space for tens of cosmonauts on spaceships of the most different types. In the course of further flights it was established that such spaceflight factors as the radiation and meteor danger are not a serious threat in circumterrestrial orbits. The design and construction of spaceships reliably protects the crew against the vacuum of space, low temperatures and solar radiation. However, on all flights the cosmonauts were subjected to weightlessness. The accumulated experience of space flights is evidence that weightlessness exerts a definite physiological effect on living organisms.

Before space flights the cosmonauts undergo prolonged training under conditions simulating a state of weightlessness. This is done using basins in specially equipped aircraft. Successful overcoming of the weightlessness effect will be dependent on further investigations of adaptability of the living organism.

During the flight of the "Soyuz-6," "Soyuz-7" and "Soyuz-8" spaceships seven flier-cosmonauts for the first time carried out simultaneous investigations, in particular, biomedical. A careful analysis of the results of these investigations, such as comparison of the effect of weightlessness on each of the seven cosmonauts, enabled scientists to obtain new data necessary in the planning of prolonged space flights. It is entirely possible that during prolonged flights of crews on orbital stations it will be necessary to create artificial gravity.

The further improvement of life support systems is also of great importance. The cosmonauts in spaceships are in comfortable conditions since the reserves of life support systems completely satisfy their need for air, heat

and food. However, an increase in the duration of flights will lead to a substantial increase in the weight of these systems.

It is known that one man on a spaceship in the course of one day requires a minimum of about 700 g of food, 2.5 liters of drinking water, 800 g of oxygen and about 5.5 liters of general-purpose water. If the spaceship crew consists of three men, during a one-year flight the total weight of the reserves for the life support system will be more than 11 tons. And indeed, as time passes still more numerous crews will begin to work on orbital stations. This problem can be solved in different ways. In particular, transport ships will periodically be able to deliver to orbital stations the necessary supplies of food and other expendables. Studies for improving life support systems for the purpose of regenerating water, oxygen, and to some degree, food, merit attention.

The activity of man in open space merits particular attention in the development of cosmonautics.

During space flights the emergence of cosmonauts from ships is necessary primarily for carrying out scientific observations, repair of equipment, erection-assembly work in creating orbital stations and direct investigations of celestial bodies in open space.

The Soviet cosmonaut Aleksey Leonov for the first time on the "Voskhod-2" spaceship emerged into open space. This demonstrated the fundamental possibility of man's presence outside a spaceship. During the elapsed period the equipment ensuring such human activity was considerably improved. The cosmonauts wear self-contained life support systems on their backs. These enable them to move freely outside the spaceship and to carry out the necessary work.

The important advances of mankind in the exploration of space constantly find their reflection in the activity of the IAF. At the IAF council administrative bureau sessions new policies were adopted on the definition, registry and certification of space records. Now the IAF sports listings include such categories as records of the duration of man's presence in space outside a spaceship, the total time of a space flight by a cosmonaut with his repeated presence in space, records for the accuracy of landing, duration of flight and total mass of the space vehicles in a docked state, and record attainments associated with manned flights to other planets.

Records for the altitude of space flight are now registered separately for maneuvering ships, that is, those which change their flight altitude by use of their own engine, and nonmaneuvering. As already noted, extremely important proposals were introduced by representatives of the Soviet Union on the registry of records in dependence on the number of crew members. The entire course of development of space technology shows that with the improvement of spaceships and an increase in the volume of work in space

there is a corresponding increase in the number of crew members and the range of their tasks becomes more and more differentiated. It is becoming mandatory that a spaceship carry a commander, ship's engineer and scientist. As demonstrated by the flights of the Soviet "Soyuz" ships, this makes it possible to carry out not only the broad maneuvering of ships for the purpose of testing methods for creating new space systems, but also complex scientific-technical experiments.

The group flight of the three Soviet spaceships was regarded highly by the world community as a new scientific-technical achievement. As world records the IAF certified the results of the group orbital flight of two spaceships with five cosmonauts aboard: flight duration - 35 hours 19 minutes 33 seconds, flight range of 989,242 km. These records were established by flier-cosmonauts A. Filipchenko, V. Volkov, V. Gorbatko, V. Shatalov and A. Yeliseyev.

As world records the IAF certified the results achieved in group orbital flight of three spaceships with seven cosmonauts aboard: flight duration of 4 hours 24 minutes 29 seconds, flight range 123,425 km. These records were established for the first time in the world and the holders were the Soviet flier cosmonauts G. Shonin, V. Kubasov, A. Filipchenko, V. Volkov, V. Gorbatko, V. Shatalov, A. Yeliseyev.

Eighteen Days in Space

A fine rain was falling at the launch pad at the cosmodrome when a bus pulled up to the rocket, which was illuminated from different sides by searchlights, and the cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov emerged. The hands of my stopwatch showed 2000 hours. Two hours prior to the launching the ship commander of the "Soyuz-9" Andriyan Nikolayev and the ship's engineer Vitaliy Sevast'yanov occupied their places in the cabin of the space laboratory.

At exactly 2200 hours on 1 June 1970, after the usual radio commands, a sharp tremor was heard over the desert steppe. A bright flaring of fire erupted from beneath the rocket. It became very bright all around the rocket. The noise increased. The rocket, freed of the servicing structures, transported the ship into space. Thus began the flight of the Soviet "Soyuz-9" ship.

The "Soyuz-9" spaceship is a manned ship for prolonged orbital flight. With respect to construction and makeup it is for the most part identical to the "Soyuz" ship, but there is some difference caused by the duration of orbital flight and the necessity for carrying out a great number of scientific-technical and biomedical experiments. The orbital compartment of the ship was supplied with containers with water and juices with a capacity of 55 liters, food rations in cans, packets and tubes, a system for collecting the products of vital functions of the crew, various items for ordinary living, including means for personal hygiene, hammocks, sleeping bags, food

heater, electric razor, attachments for sucking up dust, special vests with shock absorbers and an area for carrying out a complex of physical exercises and additional types of harness for holding the cosmonauts in different positions when carrying out scientific experiments.

All the systems ensuring approach, docking and emergence into space were taken from the "Soyuz-9" ship. This made it possible to increase the amount of scientific-technical and biomedical apparatus necessary for the planned investigations.

The cosmonauts A. Nikolayev and V. Sevast'yanov prepared for flight a long time, stubbornly and insistently. This is understandable. They were faced with a multiday space flight, investigations and experiments under unusual conditions. I have in mind the work of the cosmonauts under weightlessness conditions. Whereas Andriyan Nikolayev had already experienced this state in the course of four days in August 1962 when he and Pavel Popovich made the world's first group space flight, for Vitaliy Sevast'yanov this was the first flight. Good preparation plus the experience of the ship's commander A. Nikolayev made it possible to cope successfully with the planned flight program.

Broad tasks were assigned to the "Soyuz-9" crew. Under conditions of a single orbital flight they had to carry out a number of biomedical investigations for studying the influence of spaceflight factors on the human body; carry out scientific observations and photograph geological-geographic features, land and water surfaces in different regions of the earth for the purpose of testing methods for using the collected data in the national economy; to observe, investigate and photograph atmospheric formations, the earth's snow and ice cover, in order to use observation data in routine and long-range meteorological forecasting. In addition, the cosmonauts A. Nikolayev and V. Sevast'yanov had to carry out scientific investigations of physical characteristics, phenomena and processes in circumterrestrial space and carry out experiments for the further testing of manual and automatic control systems, similar systems for orienting and stabilizing the ship and checking autonomous means for navigation in different flight regimes. As is well known, they carried out the program in its entirety.

The flight of the manned "Soyuz-9" spaceship is a qualitatively new stage in the mastery of space. The orbital flights, especially long ones, are characterized by enormous nervous tension, physical load, and require from the cosmonauts qualities of will and restraint and the capacity for controlling one's feelings. In this connection in the general program for preparations for space flights great attention is devoted to the instilling of high moral-will qualities in the cosmonauts.

On 19 June 1970 at 1352 hours the "Soyuz-9" spaceship at an altitude of 189.9 km was oriented by means of a low-thrust engine and only then, at 1417 hours and 30 seconds, that is, after 26 minutes 30 seconds, the braking engine was

fired in accordance with the automatic cycle. The ship's velocity began to decrease and accordingly there was also a decrease in flight altitude.

Before entry into the dense layers of the atmosphere there was a separation of the ship's compartments (orbital, instrument-assembly and descent modules). The controlled descent of the descent module in the atmosphere began. At 1444 hours 14 seconds, that is, after 27 minutes 16 seconds, the parachute landing system was put into play. The hatch lid was shot off and the drag and then the main parachutes were released and opened.

Being at this time in the search team helicopter, we all clearly saw how smoothly the "Soyuz-9" spaceship descended. Several meters from the ground the solid-fuel soft-landing rocket engines were fired. The ship slowly descended onto a plowed field. The landing time for the "Soyuz-9" was 1458 hours 55 seconds. Thus, 41 minutes 25 seconds had elapsed from the time of firing of the braking engine to the landing. After the flight the cosmonauts Nikolayev and Sevast'yanov reported to the State Commission that the program for this prolonged flight had been fulfilled.

The ship commander Andriyan Nikolayev stated that the principal purpose of this flight was to study over a long period of time the effect exerted on the human body by all spaceflight factors, and, in particular, checking man's capacity for working actively under weightlessness conditions. Then he pointed out that an equally important task was a study of the process of adaptation of the human body after prolonged presence in weightlessness to normal terrestrial conditions.

The ship's crew carried out several tens of operations associated with orientation of the ship in manual and automatic regimes. During the flight they tested a number of new instruments in the systems for orientation and control of the ship's motion. In particular, for the first time they checked the ship's control during its orientation on the sun with different stipulated angles using an optical-electronic wide-angle indicator. Using it the cosmonauts carried out so-called "oblique" turns for rotating the ship at different angles to the sun during its orientation. This is necessary for maintaining the thermal regime and charging the buffer battery.

During the entire multiday flight more than 50 different experiments were carried out; these are of great scientific and national economic importance.

"After completing the flight program," stated A. G. Nikolayev, "we made a soft landing in the computed region. The flight was withstood well, but frankly speaking it was not expected that after landing some difficulties would arise in readaptation to conditions of life on the earth. It was difficult to get up from a chair. After opening the hatch, our comrades from the search team helped us to climb out of the descent module. After eighteen days of weightlessness the entire body suddenly became heavy. The sensation was as if you were sitting in a centrifuge under the influence of a small

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acceleration which began to disappear gradually and on the fifth to sixth day disappeared completely."

In conclusion the cosmonaut A. G. Nikolayev noted that after the 18-day flight of the "Soyuz-9" ship it is possible to make more reliable judgments concerning the future active participation of man in the creation and functioning of long-lived manned orbital stations.

The ship's engineer Vitaliy Ivanovich Sevast'yanov reported that the purpose of the technical experiments was not only the testing of the "Soyuz-9" ship systems under the conditions of a prolonged flight, but also the testing of new instruments of the navigation and motion control systems, determination of design and dynamic characteristics and external perturbing factors. On the flight the cosmonauts carried out testing of a new automatic sensor for orientation on the stars necessary for reliable and precise orientation of the ship against a background of strong light interference. There was successful testing of a visual optical-electronic instrument ensuring the manual orientation of the ship on the earth during flight over the shaded side.

For routine solution of navigation problems in flight the cosmonauts used on-board computers for increasing reliability of flight control. In addition, the cosmonauts carried out tests of different systems, including elements for ensuring the vital functioning of the crew and as a result of this obtained new data which are of scientific and technical interest. "All the ship systems operated normally in flight and we can state with assurance," indicated V. I. Sevast'yanov, "that the 'Soyuz' ship is capable of ensuring man's prolonged presence under spaceflight conditions."

The crew also carried out experiments for investigating the functioning of the vestibular apparatus, external respiration functions, dynamics of arterial pressure, nature of pain sensitivity of the skin, contrast sensitivity of the eyes and retention of the characteristics of the visual apparatus, muscle strength of the hands and muscular-vascular sensitivity. "Our observations," noted V. I. Sevast'yanov, "indicated that the cosmonaut very rapidly adapts to a state of weightlessness. None of us experienced any illusory sensations. However, in the course of the first two or three days of the flight we noted some symptoms such as a blood flow to the head, a feeling of some discomfort which later completely disappeared. On the first and second days of the flight weightlessness exerted an influence on the structure of movements. On the third day of the flight, when the period of adaptation to weightlessness had ended, the movements were unusually light, buoyant, accurate and sure, and with respect to movements from one ship compartment to another, even automatism appeared."

In conclusion flier-cosmonaut V. I. Sevast'yanov stated that in the flight it was possible to obtain many materials whose detailed study will enable scientists and specialists to proceed along the line of creating long-lived orbital stations and with a knowledge of this matter prepare the cosmonauts for more prolonged space flights.

It is difficult to overevaluate the importance of the flight of the "Soyuz-9" spaceship and the scientific and technical experiments carried out by the USSR Flier-Cosmonauts A. G. Nikolayev and V. I. Sevast'yanov. This flight will enter into the history of cosmonautics as an important step opening up new prospects for the mastery of space.

As a result of the processing of all the parameters of orbital flight by the coordination-computation center it was established that the total duration of flight of the "Soyuz-9" ship in circumterrestrial orbit was 424 hours 58 minutes 55 seconds and the ship flew 11,889,027 km. Thus, the crew of the "Soyuz-9" spaceship established two absolute world records and two world records for multiplace spaceships in the class of orbital flights. From now on the table of world records of achievements will include the names of the famed conquerers of space, the Soviet cosmonauts A. G. Nikolayev and V. I. Sevast'yanov.

The IAF during the multiday space flight in the "Soyuz-9" ship, as a result of handling a complex and extensive program of scientific-technical and biomedical investigations, and the establishing of absolute world records for the duration and range of flight, awarded the USSR Flier-Cosmonauts A. G. Nikolayev and V. I. Sevast'yanov the Yu. A. Gagarin Gold Medals, De la Vaulx medals and diplomas.

Space Laboratory in Orbit

A carrier-rocket with the "Soyuz-10" spaceship was launched into space from Baykonur cosmodrome on 23 April 1971 at 0254 hours. The ship carried a crew which included three cosmonauts: the "Soyuz-10" commander Vladimir Aleksandrovich Shatalov, ship's engineer Aleksey Stanislavovich Yeliseyev and engineer-researcher Nikolay Nikolayevich Rukavishnikov.

The purpose of launching of the "Soyuz-10" ship was to carry out a series of joint experiments with the "Salyut" orbital scientific station which was put into an earth satellite orbit on 19 April. By the time of launching of the "Soyuz-10" ship the "Salyut" station had made 64 revolutions around the earth. The program for the joint flight of the "Soyuz-10" and "Salyut" provided for complex checking of the improved on-board systems of the ship, testing of the manual and automatic systems for control, orientation and stabilization of the ship in different flight regimes and carrying out a series of biomedical investigations.

The "Soyuz-10" ship commander Vladimir Shatalov and ship's engineer Aleksey Yeliseyev before this had already twice had the opportunity to make flights in space. This was the first space flight for engineer-researcher Nikolay Rukavishnikov. After the "Soyuz-10" ship was put into the computed orbit the cosmonauts immediately proceeded to checking of all the on-board systems and preparations of the spaceship for the carrying out of experiments from the "Salyut" station.

The crew of the "Soyuz-10" ship carried out search, distant approach and docking. At 0447 on 24 April the "Soyuz-10" spaceship docked with the orbital station "Salyut." The flight of the ship and station in a docked state continued for 5 hours 30 minutes. The creation of the "ship-station" system was carried out by the "Soyuz-10" crew in two stages. In the first stage the approach of the ship to the station to a distance of 180 meters was accomplished in an automatic cycle. In the second stage all the operations for approach and docking were carried out by the cosmonauts. After carrying out the planned experiments the crew carried out undocking and the withdrawal of the "Soyuz-10" from the "Salyut" station.

At 0240 hours on 25 April the "Soyuz-10" spaceship with the cosmonauts V. A. Shatalov, A. S. Yeliseyev and N. N. Rukavishnikov made a soft landing 120 km to the northwest of the city of Karaganda. The search team and sports commissar awaited the cosmonauts at the landing site.

The flight of the "Soyuz-10" ship lasted for two days. During this time the crew was present in space for 47 hours 46 minutes and covered a distance of about 1,340,000 km. USSR Flier-Cosmonauts V. A. Shatalov and A. S. Yeliseyev established a singular record for repeated flight in space. In our country these two cosmonauts were the first to make three flights in space in manned ships.

The cosmonaut V. A. Shatalov during the three flights was present in space for about 10 days, flew 237 hours 18 minutes and covered a distance of 6,436,100 km. The cosmonaut A. S. Yeliseyev after the third flight in 10 days has to his credit a total flight time of 238 hours 43 minutes and covered a distance of 6,463,200 km.

Heroic Flight of the "Soyuz-11"

On 6 June 1971 we were witnesses of the eighteenth launching of a manned spaceship, the "Soyuz-11." This took place at 0755 hours at the Baykonur cosmodrome.

The State Commission assigned to the crew of the "Soyuz-11" spaceship, with a crew consisting of commander G. T. Dobrovol'skiy, ship's engineer V. N. Volkov and engineer-researcher V. I. Patsayev, the major and important task of docking with the "Salyut" orbital scientific station, accomplishing a transfer into the latter and over a period of many days carrying out the planned scientific-technical investigations and experiments.

I had an opportunity to observe how the "Salyut" station and the rocket, as well as the "Soyuz-10" and "Soyuz-11" spaceships, long before the launching were prepared in the assembly-test building at the cosmodrome for flight into space. Scientists, engineers, technicians and laborers worked day and night near these unique vehicles, preparing them for carrying out responsible work in space orbits.

Our scientists for the first time during the entire history of man's active conquest of space have succeeded in solving a complex scientific and technical problem and the creation of a manned orbital station. This required years of stubborn, insistent work of many teams of workers. We know that in January 1969, as a result of the docking of two manned multiplace spaceships, the "Soyuz-4" and "Soyuz-5," an experimental space station was created for the first time in history.

The successful space flight of the "Soyuz-4" and "Soyuz-5" made it possible to solve many scientific and technical problems having great practical importance for the creation of future orbital stations.

We know that in spaceflight the human body is acted upon by many factors: accelerations, vibrations, noise, and naturally, weightlessness.

Weightlessness is a great problem for the scientists of many countries of the world. We have already said that the cosmonauts who made flights into space and who experienced this unusual state felt differently. Some sensed a pleasant lightness, others experienced illusions of falling, being turned upside down, and a loss of spatial orientation; in some weightlessness caused strong attacks of "sea sickness." Accordingly, it is no accident that in the Soviet Union and in the United States a number of experiments have been carried out in space which involve the presence of man and animals in a state of weightlessness.

After 14 days of flight on the "Gemini-7" ship in 1965 the American astronauts Borman and Lovell, as a result of some body dehydration, lost 4.3 and 2.7 kg of weight respectively. The astronauts experienced an irritation of the mucous membrane of the nose and eyes and a brief decrease in tone; one of them (Borman) slept restlessly.

In 1966 the satellite "Kosmos-110" was launched into the orbit of an artificial earth satellite in the Soviet Union. It carried experimental animals which after 22 days, after implementation of the program, landed on the 330th revolution. It was established that at the beginning of the flight the animals exhibited a decrease in muscle mass, impairment in the coordination of movements, quickened pulse, etc. Scientists also determined that at the beginning of the flight there was an increased elimination of calcium salts from the body and the animals lost weight due to a decrease in muscle mass and some dehydration. It is known that with a loss of 20% of this mineral man experiences spasms, whereas if the human body loses 15% of its water it can perish.

Long before man's flight into space different opinions were expressed concerning the influence of weightlessness on the state of the human body and its psychic activity. During the first flights the cosmonauts confirmed that this phenomenon actually brought some of them many unpleasant sensations.

Whereas the world's first cosmonaut Yu. A. Gagarin, who was in a state of weightlessness for about one hour, performed his functions without special difficulties, G. S. Titov, as we have already mentioned, tolerated this state with some unpleasant sensations (dizziness, illusions of "floating" when making sharp turns of the head, loss of appetite, etc.). On subsequent flights the cosmonauts each differently tolerated the state of weightlessness. But for the most part all the flying cosmonauts tolerated it without any appreciable deteriorations in feeling of well-being. True, A. G. Nikolayev and V. I. Sevast'yanov after completing the 18-day flight on the "Soyuz-9" ship slowly adapted to terrestrial conditions. They required a definite time for transition to the normal conditions of terrestrial life. The adaptation of the bodies of these cosmonauts to weightlessness conditions required several days, after which they could perform any operations as easily as on the earth.

It can therefore be concluded that the process of adaptation to weightlessness during the period of flight in space, like the readaptation process on the earth, transpired gradually in the cosmonauts, in several stages, depending on the individual peculiarities of the organism.

As a result of the space flights of Soviet and American cosmonauts and astronauts, much scientific material has now been accumulated on the influence of weightlessness on the psychophysiological functions of man. However, it is still too early to say that the problem is solved.

But we will return to the flight of the "Soyuz-11" spaceship. On 7 June the cosmonauts had to carry out the most responsible stage in the flight — docking. In the morning the crew initiated a special program aboard the "Soyuz-11" using the control panel; by means of this program it was necessary to carry out approach to the "Salyut" station. At 0727 hours and 47 seconds, when the distance between the ship and station was six kilometers, the engine was fired for 20 seconds and the vehicles automatically approached one another to a distance of 100 meters. Thereafter the crew performed all control work for approach and docking by manual methods. At 0858 hours the docking of the "Soyuz-11" with the "Salyut" station was completed. The crew carefully checked the tightness of the connection between the ship and station. After this the pressure in their compartments was equalized. Convincing himself that everything was normal, the engineer-researcher Viktor Patsayev was the first to transfer to the "Salyut," and he was followed by the remaining crew members. This occurred on 7 June at 1045 hours.

For the first time a crew was delivered to a scientific orbital station by a transport ship. The first manned orbital scientific station began to function in space beginning at that time. The station commander Georgiy Dobrovol'skiy reported to earth about onset of the crew's work aboard the "Salyut" station.

On the first day of presence aboard the station the crew inspected all its compartments and carried out "demothballing"; then they checked the scientific equipment. The manned scientific orbital station is an entire scientific laboratory. Its length is about 20 meters. The volume of all the compartments was more than 100 cubic meters. Weight together with the "Soyuz-11" ship was about 25 tons. With respect to design the station was constructed in such a way that the crew over a long period of time could carry out scientific-technical and biomedical investigations and experiments. For orbital correction the vehicle has rocket engines.

At 1102 hours on 8 June the crew made the first correction, as a result of which the altitude at apogee was increased by 22 km and at perigee by 29 km. On the next day the cosmonauts carried out adjustment of the on-board scientific apparatus and demothballed some systems aboard the "Soyuz-11" ship. The VShK sight (vizir shirokougol'nyy kosmonavta -- cosmonaut's wide-angle sight) was successfully checked; it was designed for orientation on the sun and planets. In addition, the crew carried out measurements of the radiation level aboard the station. Each of the cosmonauts put on a special "Pingvin" suit which creates a definite load on the bone-muscular system in a state of weightlessness.

Thus the "Salyut" scientific orbital station continued its flight in space revolution after revolution. Communication between the station and the flight control center was stable. The cosmonauts felt well. On 10 June the crew underwent biomedical investigations of the state of the cardiovascular system under weightlessness conditions. Using a special multichannel amplifier-converter the cosmonauts underwent functional tests for determining the density of bone tissues and the blood composition.

The on-board systems of the station and the scientific instrumentation operated normally. In accordance with the established schedule, the cosmonauts regularly made television reports from aboard the station. Ship's engineer Vladislav Volkov and engineer-researcher Viktor Patsayev repeatedly carried out navigation measurements, on the basis of which, using an on-board digital computer, the orbital parameters of the station were determined.

At 0755 hours on 24 June the cosmonauts G. T. Dobrovol'skiy, V. N. Volkov and V. I. Patsayev with respect to the duration and range of space flight had achieved the results which were established during the 18 days of the flight by A. G. Nikolayev and V. I. Sevast'yanov on the "Soyuz-9" ship.

Exactly after two days, that is, on 26 June, when 20 days of flight had elapsed, the crew of the manned orbital scientific station became the holders of absolute world records with respect to the duration and range of space flight. Georgiy Dobrovol'skiy, Vladislav Volkov and Viktor Patsayev by this time with respect to the mentioned parameters surpassed the world records established earlier by their friends Andriyan Nikolayev and

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Vitaliy Sevast'yanov during the space flight of 1-19 June 1970 on the "Soyuz-9" ship. The cosmonauts on the "Soyuz-11" ship and the "Salyut" station made a total of about 340 revolutions around our planet, spent more than 480 hours in space and covered a distance of 13,440,000 km. Less than four days remained prior to the end of the flight program. On 27 and 28 June the cosmonauts once again checked all the on-board systems of the station and the "Soyuz-11" ship and carried out a number of biomedical experiments. According to a report of the cosmonauts all the on-board systems of the ship and station operated normally.

29 June 1971 was the last day of the flight. Instructions on completion of the flight and preparations for the landing were sent to the orbital scientific station from the earth. The cosmonauts, being convinced of normal operation of all the systems of the ship and station, prepared for the landing. G. T. Dobrovol'skiy, V. N. Volkov and V. I. Patsayev carried the ship's journals and other materials from the scientific investigations from the "Salyut" station into the "Soyuz-11" ship. The cosmonauts occupied their work places, attached their harness, and then checked the operation of all the on-board systems of the ship. In the "Soyuz-11" compartments the pressure and temperature were normal. All the apparatus operated normally. Radio communication with the earth was normal.

At 2128 hours the "Soyuz-11" ship was successfully undocked from the "Salyut" orbital station. The crew reported about this to the earth. The "Soyuz-11" spaceship began its independent flight without the "Salyut" station. All systems of the "Soyuz-11" ship functioned normally. The flight of the "Soyuz-11" lasted about four hours in space before activation of the automatic orientation system. At approximately 0110 hours on 30 June 1971 the ship's orientation system was fired and 25 minutes later, the braking engine, which functioned for the computed time. The moment arrived for separation of the descent module from the instrument and orbital compartments. Beginning at this time communication with the crew of the "Soyuz-11" spaceship ceased. The descent module, which carried the cosmonauts Dobrovol'skiy, Volkov and Patsayev, entered the dense layers of the atmosphere. At 0202 hours the parachute system was put in the operation. The parachute was opened at an altitude of 9,000 m.

There is no communication with the cosmonauts. A group of helicopters of the search and find service approached the ship's landing site. Aircraft circled in the air. From the Mi-6 helicopter in which we were flying it could be seen clearly how the cabin of the "Soyuz-11" ship descended smoothly and slowly, wavering beneath the canopy of the large parachute. Right near the ground the solid-fuel soft-landing engines were fired. The "Soyuz-11" cabin for some instant hovered and slowly descended to the earth.

I jot down: "At 0215 hours Moscow time the descent module of the "Soyuz-11" with the cosmonauts G. T. Dobrovol'skiy, V. N. Volkov and V. I. Patsayev landed." We run to the landing site. The technical support group

opens the hatch. We help Georgiy Timofeyevich Dobrovol'skiy, Vladislav Nikolayevich Volkov and Viktor Ivanovich Patsayev from the cabin of the "Soyuz-11" ship. The cosmonauts gave no signs of life. The doctors did everything which was required of them but it was already too late.

On the basis of the preliminary conclusion of the physician Anatoliy Aleksandrovich Lebedev at the landing site, it was established that the crew perished from a sharp decrease in pressure in the ship's cabin. As was later clarified, the "Soyuz-11" crew died as a result of an impairment in ship pressurization. USSR Flier-Cosmonauts G. T. Dobrovol'skiy, V. N. Volkov and V. I. Patsayev fully implemented the program of scientific research. They made an enormous contribution to the development of orbital manned flights.

The entries made by the cosmonauts in the ship's journals, the personal reports registered on magnetic tape, and the great number of motion picture frames taken from space were studied by scientists.

During the 24 days of flight the USSR Flier-Cosmonauts G. T. Dobrovol'skiy, V. N. Volkov and V. I. Patsayev carried out an extensive complex of studies having great scientific-technical and national economic importance. They carried out, under flight conditions, testing of the "Soyuz-Salyut" system having great future importance for other ships and stations which after the "Soyuz-11" will enter into the expanses of the universe.

"Ural" Call Letters in Orbit

The laconic TASS lines reported: "In accordance with the program for investigations in circumterrestrial space, at 1518 hours Moscow time on 27 September 1973 the "Soyuz-12" spaceship was launched in the Soviet Union."

The spaceship, put into the computed earth satellite orbit, was manned by a crew consisting of ship's commander Lt. Col. Vasiliy Grigor'yevich Lazarev and ship's engineer Oleg Grigor'yevich Makarov.

Already later, returning to the earth, at a meeting with newspapermen at Zvezdnyy city, Oleg Makarov stated: "To be sure, we had some idea about space, we had looked at masses of photographs and had listened to the stories of our comrades. But reality was immeasurably richer. The earth is indescribably beautiful. I read that our planet is bluish-white from space, but I could not visualize that it was so blindingly white and blue, or that the continents were so brick red." Indeed, this was their first flight. Extremely short, if one judges from the time spent in space. However, each minute of their working time was saturated to the limit.

"'Ural','Ural', this is 'Zarya'. Do you hear us?"

"'Zarya', I hear you very clearly. I am proceeding to implementation of the prescribed research program."

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Thus began the regular communications session between the Flight Control Center and the spaceship. The flight program was quite complex. Different maneuvers were tried out on the first day. The "Soyuz" can also be an independent space laboratory or a transport ship intended for communication with orbital stations. Twice they fired the ship's engine — first at apogee and then at perigee. As a result the ship went into an almost circular orbit with the parameters:

— maximum distance from the earth (at apogee) — 345 km;
— minimum distance from the earth's surface — 326 km;
— period of revolution — 91 minutes;
— orbital inclination — 51.6°.

An important place in the flight program was devoted to autonomous space navigation. The cosmonauts checked the action of orientation control, making it possible to clarify whether the automatic system correctly turned the ship so that the engine would give an impulse in the necessary direction. Then it was time to check the operation of the instrument for nighttime vision for orienting the ship on the shaded side of the earth. All these experiments had as their purpose giving a greater autonomy to spaceships in future prolonged and distant flights and decreasing their dependence on the ground flight control center.

On another day the cosmonauts were engaged, if one can express it so, with "terrestrial" matters, that is, they proceeded to a study of the earth's surface for the purpose of investigating natural resources. Space photographs are interesting because they make it possible to cover enormous areas and in different parts of the spectrum -- from visible light to the infrared. By then comparing these photographs with larger-scale aerial photographs and with the observations of ground search parties, it is possible to detect definite patterns which make it possible to carry out purposeful investigations using photographs of individual regions taken from orbit.

However, the termination of the flight is already approaching. The cosmonauts were engaged in work and did not note how the two days had flown by. It was necessary to make preparations for a descent. Putting on their spacesuits, which they had taken off after the ship had been put into orbit, the cosmonauts closed the hatch between the descent module and the orbital compartment, first carrying into the descent module the magazines with the film and the records with the results of the investigations. The high orbit of the "Soyuz-12" made it necessary to fire the braking engine while still over the Atlantic Ocean. Finally, on the 32d revolution the ship's compartments were separated and the descent module went into a descent trajectory.

At an altitude of 7.5 km the parachute system was put into operation, the soft-landing engine was fired directly at the earth, and the descent module smoothly descended in the computed region at a distance of 400 km to the northwest of the city of Karaganda. I think that the flight evaluation given by K. P. Feoktistov is not without interest:

"If you please, it is difficult to mention another launching whose program was so saturated with dynamic operations, that is, the work of the ship itself and its engines. Everything was done calmly, without fuss. Such precision is very important for the thorough checking of the improved apparatus and instruments. And this, to be sure, is to the credit of the crew. It indicated an excellent knowledge of the equipment by the cosmonauts."

Eight Days of Orbital Flight

On the next flight the "Soyuz" spaceship was launched from the Baykonur cosmodrome. It carried aboard two courageous space explorers, two extraordinary lads -- ship commander Petr Il'ich Klimuk and ship's engineer Valentin Vital'yevich Lebedev. 18 December 1973, 1455 hours. Eight days later, on 26 December at 1150 hours, the descent module of the "Soyuz-13" ship landed safely at a distance of 200 km to the southwest of Karaganda. The task of a sports commissar is to be precise and I must add that during this time the ship made 128 revolutions around the earth and after the correction carried out on 18 December had the following orbital parameters:

-- maximum distance (at apogee) -- 272 km;
-- minimum distance (at perigee) -- 225 km;
-- orbital inclination -- 51.6°;
-- period of revolution -- 89.22 minutes.

What were the purposes and objectives of the launching of the "Soyuz-13" and what were the results of its flight?

The "Soyuz-13" was devised as an orbital astrophysical observatory capable of solving a wide range of scientific research problems. In particular, the program for the eight-day flight provided for carrying out periods of spectrographic observations of stars important for astronomy and navigation by the stars using the "Orion-2" system of telescopes carried aboard. A major place in the flight was devoted to spectrographic observations and a spectrozonal survey of individual parts of the earth's surface for the purpose of studying natural features in the territory of the Soviet Union, work having great importance for different branches of the national economy. Under the program of biomedical research with use of the "Levka" apparatus a study was made of the characteristics of cerebral circulation at different stages in the adaptation period. Using the "Oazis-2" system a study was made of the possibility of obtaining the protein biomass under weightlessness conditions. In the course of the scientific experiments it was possible to test improved orientation instruments and methods ensuring a high accuracy in pointing of the telescopes.

The "Orion" astronomical system was also carried on the orbital station. Putting this system beyond the limits of the earth's atmosphere, finally, enables astronomers to avoid the influence of the earth's atmosphere, which holds back almost the entire spectrum of electromagnetic radiation emanating from celestial bodies. Only small windows in the optical and radio ranges enable scientists to carry out observations from the earth's surface.

The "Orion-2" is a complex instrument combining optical, electronic, mechanical and electric systems. It is attached on a special platform outside the ship. The "Orion-2" system includes a meniscus telescope for spectrographic observations of stars in the UV range up to star magnitudes of 9.5-10 in an area of 20 square degrees. In order for the optical parts not to distort the images as a result of sharp temperature drops in space, they are fabricated of quartz crystal. A brilliant solution was also found for still another important problem -- precise orientation of the instrument and further tracking of the selected object. After rough pointing the telescopes by means of a special pointing system can ensure an orientation accuracy up to 2-3 seconds of arc.

For studying the earth's surface from space and carrying out a spectrozonal survey the cosmonauts used a special spectrograph developed at Leningrad University. It was designed for obtaining spectrograms and color photographs. The spectrograms and photographs obtained form a special picture archives whose creation began already at the time of flights of the "Soyuz-9" and "Salyut" station. Our scientists and cosmonauts have developed the principles of a newly forming science -- space geography (zemlevedeniye). The work done is evidence of a high effectiveness of solution of scientific and applied problems using manned space vehicles, making it possible to compare visual, photographic and other methods of space remote sensing of the environment surrounding us for different sectors of the earth's surface.

Aboard the "Soyuz-13" important work was carried out for studying the period of adaptation to weightlessness. This experiment has been given the name "Levka." At the time of special loads the cosmonauts used electrodes in registering the bioelectric potentials of the brain. These were recorded by telemetric devices and transmitted to the earth.

The cosmonauts continued investigations of regeneration processes in a closed space. The system known as the "Oazis" already operated on the "Salyut" orbital station. On the "Soyuz-13" cosmonauts carried out experiments with the cultivation of some species of microorganisms.

The apparatus consists of two cylinders -- "fermenters" for microorganisms. They hold fluid and gas. The gas moves from one cylinder to another. One of the fermenters contains hydrogen bacteria which in their growth use for the most part free hydrogen obtained in the electrolysis of water. The other holds urobacteria -- microorganisms capable of decomposing urea. They absorb oxygen forming in the first cylinder and release carbon dioxide. The carbon dioxide, in turn, is used by the hydrogen bacteria for the synthesis of biomass.

The cosmonauts activated the Oazis on the first day of the flight. For this purpose they introduced a culture of bacteria into the fermenters and then periodically fed into the cylinders a nutrient medium and took samples of biomass which were delivered to the earth for investigation.

In conclusion I would like to cite the words of one of the flight directors:

"First it should be noted that all the spaceship systems operated faultlessly, the control service successfully coped with its obligations, and other services, the telemetrists, ballistics specialists and search teams demonstrated decision and good performance... Making its debut in a new role, as a specialized astrophysical observatory, the "Soyuz" ship demonstrated the entire breadth of its capabilities.

In addition to the program of scientific research, in the course of the flight purely engineering problems were also solved. One of them was the registry of the accuracy characteristics of the system for control and testing of new instruments for orientation on the earth and stars. What does this mean? We checked the possibility of creating very precise orientation of instruments. The orientation of on-board scientific complexes by means of rotating of the ship itself involves expenditures of the working medium, and therefore the loading of the ship with a great quantity of fuel. The new decision yielded its fruits. In the course of the "Soyuz-13" flight it was sufficient to orient the ship with an accuracy to two or three minutes of angle. In this procedure the accuracy in biaxial orientation of the instruments was three to five seconds.

The success of each flight is determined by many factors. These include the accuracy in putting the ship into orbit and the continuous functioning of all on-board systems and the ground complex and the degree of preparation of the crew... The flight itself was the termination of a great amount of work carried out by large groups."

THE STORMING OF SPACE IS CONTINUING

"Soyuz-14" in Space

[Text] We took off for Baykonur cosmodrome late in June 1974 after ending preparations of the crew and "Soyuz-14" ship for the implementation of new experiments in space.

It was extremely hot. The air remained hot at all times during the day. Despite this, all the work in preparing the launching complex, carrier-rocket and ship with the cosmonauts was carried out in accordance with the established schedule.

The launching of the rocket and cosmonauts was set for 3 July. During the two days before the flight into space the makeup of the "Soyuz-14" crew was approved by the State Commission.

The crew consisted of Pavel Romanovich Popovich, the ship's commander, and Yuriy Petrovich Artyukhin, the ship's engineer.

Twelve years ago the the excited voice of the "Vostok-4" commander was heard from orbit: "'Vostok-4': 'I am 'Berkut!' 'I see the 'Sokol'!"

"Berkut" was Pavel Romanovich Popovich; "Sokol" was Andriyan Grigor'yevich Nikolayev.

The world's first group flight of spaceships took place in August 1962. On this flight P. R. Popovich participated in the "Vostok-4" ship. At that time P. R. Popovich was alone in the ship and now he had to make a space flight together with the ship's engineer Yu. P. Artyukhin.

On 3 July 1974, two hours before the launching the cosmonauts occupied their places in the ship. The voices of the cosmonauts and those who were directing their flight were heard over the loudspeakers.

"Temperature in the DM (descent module) 23 degrees."

"The spacesuits are airtight."

"Activate the emergency rescue system!"

"Launching switch!"

"Ignition!"

Several seconds remain before the launching. Heavy rumbling rolls around us. The rocket slowly separates from the launch pad. The chronometer reads 21 hours 51 minutes. The new, next flight of a Soviet ship in space has begun.

There is stable radio and television communication with the "Soyuz-14" ship. After entry into circumterrestrial orbit the cosmonauts proceeded to the implementation of the flight program. By 1600 hours on 4 July the "Soyuz-14" spaceship had made 13 revolutions around the earth. The crew began preparations for carrying out docking with the "Salyut-3" orbital scientific station which was put into orbit on 25 June 1974.

The docking of the "Soyuz-14" ship with the "Salyut-3" orbital scientific station took place on 5 July 1974. After some time the cosmonauts P. R. Popovich and Yu. P. Artyukhin moved into the station compartments. The scientific manned "Salyut-3" station began to function from this time in space. In order to carry out all the maneuvers with docking of the ship with the station it was necessary not only to have a great accuracy of all the systems, but also a smoothness of work by the spaceship crew.

On the 18th revolution Popovich reported:

"Active approach is in progress. Distance 300 meters."

The cosmonauts saw the "Salyut-3" in the optical sight and on the television screen. At 100 meters from it the "Soyuz-14" commander took over manual control and brought the ship to a distance of about 40 meters from the station. The final stage in the docking was carried out by the commander of the "Soyuz-14" ship precisely at the stipulated time.

The work program for the crew of the "Salyut-3" manned orbital scientific station included carrying out scientific-technical, biomedical experiments;

testing an improved system for design of the station and also the on-board systems and apparatus;

study of the physical characteristics of space;

investigation of geomorpholcgical features on the earth's surface, atmospheric formations and phenomena;

biomedical investigations for study of the influence of spaceflight factors on the human body and determination of rational work regimes of the crew aboard the station and many other experiments.

Candidate of Technical Sciences V. Ivanov on the pages of the journal AVIATSIYA I KOSMONAVTIKA emphasized the great importance of flight of the "Salyut-3" orbital station as a new stage in the space investigations carried out in the Soviet Union:

"One of the principal tasks assigned the crew of the station consisting of P. R. Popovich and Yu. P. Artyukhin was an investigation of geomorphological features on the earth's surface and also atmospheric formations and phenomena."

What was the importance of these investigations and how did the cosmonauts carry them out?

In communications during the time of the flight it was pointed out that the cosmonauts observed and photographed different features on the earth's surface. In particular, photographs were taken of the Caucasus region and the Ustyurt Plateau. It was pointed out that they will be used in a study of the geological structure of these regions, monitoring of agromelioration measures, determination of forest resources, study of the dynamics of the shoreline of the sea.

On one of the days the cosmonauts made a survey over extensive lowland and mountain regions of the republics of Central Asia and the Pamirs. These photographs are necessary for detecting areas promising from the point of view of the search for minerals, inventory of lands subject to salinization, and also for determining promising soil resources, evaluating the state and predicting the movement of glaciers.

Through the optical sight the crew observed the state and development of cloud formations and photographed them. The cosmonauts carried out spectrographic measurements of individual natural features on the earth's surface. These data were intended for a catalogue of spectra of characteristic types of the earth's surface, for further improvement of methods for studying natural resources and evaluating the state of the environment.

We have mentioned only a small part of the experiments carried out in flight and also the principal methods for obtaining information on the earth and its atmosphere, visual observation, photography and spectrographic studies.

Why has so much attention been devoted to investigation of geomorphological features on the earth's surface and atmospheric formations?

We now have meteorological, communications, geodetic, navigation and other satellites for practical purposes. They all symbolize the development of a major stage in space research and have already brought many results of practical usefulness. However, the mentioned satellites are only the first step in the study of our planet by space vehicles. Possibilities of

studying the earth's nature, the wealth of its deep layers and the ocean from space are truly unlimited.

Long-term cycles of continuous and complex observations, constituting a broad class of problems in such investigations, can be carried out most effectively from long-term orbital stations whose crews include specialists trained for carrying out the corresponding scientific programs.

One of the important advantages of such stations is that aboard them it is possible to analyze the developing conditions and select the objects for investigation under the most favorable conditions for their observation and also determine the complex of instrumentation used.

That was what was done on the flight of P. R. Popovich and Yu. P. Artyukhin.

A television report from aboard the station was made on the 176th revolution at 2310 hours on 6 July 1974.

The fourteenth working day of Pavel Popovich and Yuriy Artyukhin aboard the station began at 0950 hours on 18 July 1974.

In carrying out the program for the next working day, the cosmonauts proceeded to the operations preceding the landing of the descent module of the "Soyuz-14" transport ship on the earth. The crew checked the docking units, control systems, autonomous electric power supply, engines and other ship systems.

At this time, at the "Soyuz-14" landing site, in the vicinity of Dzhezkazgan city, preparations were made for meeting the ship's crew

On 19 July, by 1200 hours, the search-rescue service was ready to meet P. R. Popovich and Yu. P. Artyukhin on their native earth.

At 1400 hours helicopters rose in the air. They carried physicians, technical directors and a sports commissar.

Then I look out the helicopter window. The boundless steppe is down below. The air temperature is +40°. It is very hot. The helicopter engines are overheating.

At 1203 hours on 19 July 1974 the "Soyuz-14" ship undocked from the "Salyut-3" station. At the computed time the braking engine of the "Soyuz-14" ship was fired for accomplishing a descent to earth. Upon completion of engine operation the compartments were separated and the descent module entered a descent trajectory. At the computed altitude the parachute system was activated and the soft-landing engines were fired directly at the earth's surface. At exactly 1521 hours on 19 July 1974, at a distance of 140 km to the southeast of Dzhezkazgan city, the descent module with the cosmonauts P. R. Popovich and Yu. P. Artyukhin made a soft landing. Thus came

to a successful close the 15-day program of scientific and technical investigations in the joint flight of the orbital station "Salyut-3" and the transport ship "Soyuz-14." The "Salyut-3" ship continued flight in an automatic regime.

Very valuable data of a scientific-technical and biomedical nature were obtained as a result of this flight. On 21 July 1974 the residents of Zvezdnyy met the space heroes. P. R. Popovich and Yu. P. Artyukhin during 18 days had flown in space 378 hours 30 minutes and covered a distance of 10,584,000 km.

The "Soyuz-15" is in Star Orbit

The "Soyuz-15" spaceship was launched from Baykonur cosmodrome on 28 August 1974 at 2258 hours. It was manned by a crew consisting of ship commander Lt. Col. Gennadiy Vasil'yevich Sarafanov and ship's engineer Col.-Engineer Lev Stepanovich Demin.

The "Soyuz-15" transport ship was launched for continuing scientific investigations and carrying out experiments in space together with the "Salyut-3" station.

Gennadiy Sarafanov was in the cosmonaut detachment since 1965. He was a graduate of the Advanced Military Training School for Airmen.

Lev Demin was in the cosmonaut detachment since 1963. In 1945 he graduated from the Military Aviation School of Communications. Beginning in 1949 he was an auditor and then an adjunct at the Air Engineering Academy imeni N. Ye. Zhukovskiy.

After entry into orbit the crew of the "Soyuz-15" ship began to carry out the flight program. By 1700 hours on 27 August the "Soyuz-15" spaceship had made 12 revolutions around the earth.

The orbital parameters of the ship are as follows:

maximum distance from the earth's surface (at apogee) -- 275 km;
minimum distance -- 254 km;
period of revolution -- 89.6 minutes;
orbital inclination -- 51.6°.

By 0800 hours on 28 August the "Soyuz-15" ship had made 22 revolutions around the earth. In the course of the flight the cosmonauts Sarafanov and Demin carried out experiments for testing equipment for pilotage of the ship in different flight regimes. The ship's crew repeatedly brought the "Soyuz-15" close to the "Salyut-3" station, monitoring the operation of all the ship's systems and observing the stages in approach to the station. While carrying out maneuvers for approach to the station Gennadiy Sarafanov and Lev Demin carried out its external examination. After

this the crew was given a command for preparing the spaceship for return to the earth. The "Salyut-3" station continued its flight in an automatic regime in accordance with the stipulated program.

Up to 1600 on 28 August, when the ship was situated outside the zone of radiovisibility from the territory of the Soviet Union, the cosmonauts rested. After rest, the Flight Control Center sent to the "Soyuz-15" information concerning the time of firing of the braking engine for descent of the ship from orbit.

At 2224 hours 38 seconds on 28 August 1974 the braking engine was fired. A total of 46 minutes 38 seconds remained before the landing of the ship and its crew. The braking engine was fired and the orbital and instrument compartments were separated from the ship's descent module. The descent module with the cosmonauts Sarafanov and Demin went into a descent trajectory.

Aircraft and helicopters of the search-rescue service under complex meteorological conditions flew out to the computed landing site of the "Soyuz-15" ship. The search zone was established for each aircraft and helicopter. All the radioelectronic systems for monitoring, detecting and direction finding operated continuously. The command point maintained stable and continuous radio communication with all the flight vehicles present in the air. When the ship passed through the dense layers of the atmosphere, the braking parachute was opened at an altitude of about 4,000 m. Aircraft direction finders zeroed in on the ship.

A communication arrived at the control center: communication was established with the ship's crew. And now the helicopter crew in the search group saw the descent module in the air.

At 2310 hours, at a distance of 48 km to the southwest of Tselinograd, the descent module with the cosmonauts Gennadiy Sarafanov and Lev Demin made a soft landing. After 10 minutes one of the search group helicopters landed alongside the descent module. The first hour of the coming 29 August local time arrived. Seventeen minutes after the landing the cosmonauts seated themselves in the helicopter, which soon delivered them to the Tselinograd airport.

The cosmonauts Gennadiy Sarafanov and Lev Demin were greeted with flowers, embraces and smiles on 30 August 1974 at Zvezdnyy.

Thus, still another step had been taken into the unknown and new launchings, new flights of Soviet cosmonauts, were still ahead.

Baykonur Cosmodrome

In this book we have attempted to tell about space flights, about cosmonauts, their instruction, training, their heroism, scientific results of the flights and their record attainments. But the picture will be incomplete unless we at least briefly tell about the cosmodrome from which the cosmonauts begin their path into space.

Baykonur is one of the largest cosmodromes of the Soviet Union. On 4 October 1957 the world's first artificial satellite was launched from its launch pads, followed by the world's first spaceflight of Yu. A. Gagarin and the launchings of Soviet flier-cosmonauts into the unexplored expanses of the universe in the "Vostok," "Voskhod" and "Soyuz" spaceships. It was here that automatic space stations were launched in the direction of the moon, Mars and Venus, as well as being the site of launching of artificial earth satellites different in their purpose, use and application.

Over the area of the cosmodrome there are a number of launching complexes, technical posts and command-measuring complexes. The launching complexes are used for delivery of spacecraft to the launch pad, setting up in a firing position, testing, fueling and launching.

At the technical posts there are facilities for the reception, storage and assembly of carrier-rockets and space apparatus, for their testing, fueling and erection. Here one finds the assembly-test building, the station for fueling of space objects, compressor station, electric power or transformer substations and service buildings.

The command-measuring complex includes measurement stations located at the cosmodrome. At these points there are radiotelemetric stations, radio receiving and radio transmitting apparatus, antenna systems, television apparatus, lines for the automatic processing of the collected data, computers, standard time service apparatus, communications facilities and sources of electric power.

Those who first laid the foundations of the launch pad and constructed Zvezdograd live and work at the cosmodrome.

Here, to the cosmodrome, extend the vital strands of close communication between the workers of the cosmodrome and many scientific research institutes, design offices, factories, organizations and institutions.

As a sports commissar I frequently had the opportunity to be at the cosmodrome. Always when you fly in for the next launching you are captured by the excitement caused by the impending flight of our flier-cosmonauts into space.

Immediately after landing of the aircraft we drive from the airport to Zvezdograd where scientists, engineers, technicians and many other workers of other services and subdivisions live. Zvezdograd is a large modern city with broad straight streets, green squares, boulevards and parks. It is under construction, is being expanded and is being beautified.

Let's walk through Zvezdograd. Not far from the central square in the city, alongside the living quarters, are two two-story houses. On those April days of 1961 Yuriy Alekseyevich Gagarin lived, rested and prepared for his flight into space in one of them. In memory of his presence here in 1961 the cosmonaut planted in the park, not far from this house, a small tree which has now grown up. When Yuriy Alekseyevich flew into the cosmodrome he always lived in two adjacent rooms in the left wing of the building. The cosmonaut remained true to tradition; after all, his recollections of his first flight were associated with these rooms. And we with great excitement listened to his story about the prelaunching days.

"When I flew in here for the first time in 1961, several days before my flight into space," he said to us, "I saw a great number of construction sites. Builders were erecting new residences, motion picture theaters, stores, administrative-technical complexes, and constructing highways."

Yu. A. Gagarin told us that the training sessions and exercises took place on the first floor of this house in special rooms. In addition, he and his stand-in G. S. Titov frequently had to drive to the launch pad and carry out training sessions directly in the spaceship, playing through all parts of the impending flight.

Now a beautiful new two-story guesthouse has been constructed at the cosmodrome on the outskirts of the city. The flier-cosmonauts live, study and prepare for flights there. The name of this guesthouse is the "Kosmonavt." Yu. I. Gagarin and other cosmonauts took an active part in the planning of this building. At the cosmodrome I was a witness to a conversation between Yu. A. Gagarin and other cosmonauts with designers and builders when the matter of constructing this building arose. On the proposal of Yu. A. Gagarin a decision was adopted to construct an open basin, to enlarge the sports hall, to build special rooms for carrying out exercises and training sessions.

The cosmonauts proposed that a sports complex be constructed on the hotel grounds, together with rooms for doctors and other specialists. All three proposals were adopted. Now the hotel is a comfortable home which affords the possibility to cosmonauts and specialists for preparing for the impending flights and it is interesting to carry out exercises during the time free from training.

Several trees which are planted strictly in a row attract our attention. This is the avenue of the cosmonauts. The number of trees on this avenue corresponds to the number of cosmonauts who have made flights into space.

One of the highways which leads us to the launching complexes, technical positions and measurement stations runs not far from the "Kosmonavt" hotel. On two sides of the sandy plain one can see individual desert saksaul plants. It is true that in early spring tulips bloom everywhere here; they disappear rapidly and then reappear again.

Thus, we go along the road to the launch pad. The vehicle whirls along the asphalted road. After some time we are in place. To the right of us several houses are built in a single row. There are memorial placards on two of the houses. On one of them we read: "The Chief Designer Academician Sergey Pavlovich Korolev lived and worked here 1956-1966"; on the other house is a placard with an inscription reading as follows: "Yuriy Alekseyevich Gagarin spent the night in this house preceding history's first manned space flight, 11-12 April 1961."

A large building stands not far from the houses. This is the assembly-test building. Here workers assemble spaceships and the individual stages of the carrier-rocket and also join the rocket to the ship and carry out all complex tests. A great number of specialists work in the assembly-test building. On them literally everything depends -- ranging from highly complex systems, units, components and assemblies of the carrier-rocket, launching apparatus, and spaceships and running through the launching of our cosmonauts into space.

Always when I arrive at the cosmodrome before the next launching into space I without fail visit the assembly-test complex for carrying out my obligations as a sports commissar. More than once I had the opportunity, here in this building, of observing the entire technological process of preparations for flight of ships and carrier-rockets into space.

Here before us stands the next spaceship, which on all sides, from the instrument compartment to the orbital compartment, situated at the top of the ship, is surrounded by a "forest" of movable work places, closely adjacent to it.

This is one of the "Soyuz" ships, which must together with the next crew carry out orbital flight around our planet.

People working in white gowns at their work areas are preparing this complex and unique structure, created by a team of scientists, engineers and workers, for flight into space. Here, not far from the ships, at all times we see the main designer, with whom during many years of joint work with us we have established good, friendly interrelationships. With great interest I observe the clear and smooth work of people in white gowns. What is it possible to compare the work of these workers with? With the work of a pharmacist, clockmaker or surgeon? It is difficult to say. They check everything, like pharmacists, deal with parts and assemblies which in their complexity far surpass the most precise modern, most miniature clock mechanisms. But in their scrupulosity the men in the white gowns are similar

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

to surgeons performing complex operations. One can admire their truly precision work for hours.

Stages with powerful rocket engines lie alongside the ship in this enormous room; after their assembly a carrier-rocket is formed. Many specialists are working here; they are checking engines with various kinds of telemetric, automatic apparatus and other systems.

And now the spaceship has been completely prepared for joining to the rocket. But it is too early to carry out this work. The fact is that under the program for prelaunching preparation the cosmonauts must undergo special training sessions in the ship cabin where diversified complex apparatus is installed. The cosmonauts occupy their places in the ship's cabin and for long hours undergo training sessions of various types with numerous instruments, reducing their actions to automatism.

When I glanced through the entry hatch into the ship, its commander was checking the radio equipment and the power system. Other crew members were checking the life support system, television cameras and motion picture apparatus. The ship's commander in a conversation with his colleagues on the impending flight was refining the actions of each of them in the case of failure of the ship's automatic orientation system and radio communication in the short-wave channel. The cosmonauts respond with assurance and accuracy to the questions of their commander. It is felt that the program for the ground preflight training has been successfully run through by the members of the "Soyuz" ship's crew. They are sure that all its systems will operate faultlessly. But nevertheless the crew must be ready for every contingency. Here it is fitting to recall that already long ago, with the appearance of the first flightcraft, in aviation there was adherence to the principal established rules for the training of a flier or an entire aircraft crew for impending flights along a route, in a zone or in a circle. An airman can be admitted to aircraft flight only in a case when he thoroughly knows the materiel part of this flightcraft, its equipment, is able to keep up radio communication and is freely oriented in the air, carries out assigned maneuvers when coming in for a landing and without fail excellently pilots the aircraft.

Cosmonauts, like pilots of aircraft, first of all perfect flight, first pass through ground preparation, then preliminary and preflight training, during which they "play through" all the elements of their flight, ranging from takeoff to landing.

In the program for the training of cosmonauts great attention is devoted to knowledge and the ability to make in-flight use of all systems and instruments in solving the most diversified problems in space flight.

Finally comes the time for carrying out operations involved in joining the spaceship to the rocket. The ship is set in a horizontal position and it is "fitted" in a fairing. At this time the rocket, already fully

prepared, is slowly moved up to the spaceship and it is attached to the ship by fastenings. Only a few days remain before the launching. Tomorrow the rocket and the ship will be moved out from the assembly-test building to the launching position. Specialists remain near the rocket. Once again it is necessary to examine and check everything.

Early in the morning the rocket is transported from the assembly-test building for placement on the launch pad. We stand by an enormous door on the opposite side of the assembly-test building. The door slowly opens. The rocket with the spaceship lies in the building on a special long platform. A motorized crane slowly approaches the platform. The crane carries this unique technical creation of our century on a long platform. And here is the launch pad.

We attentively observe how the powerful hoists grasp the rocket with the spaceship and set it in its place. Now it is still necessary to perform another important and responsible task -- fueling the rocket, checking all the ship's systems, all the carrier-rocket systems and accomplishing launching. Two hours before the launching the cosmonauts take their positions in the spaceship. Radiocommunication is established with them. On the television screen it can be seen how the cosmonauts are checking all the ship's systems.

The commands familiar to all of us are given several minutes before the launching: "Scavenge," "Drainage switch," "Start," "Draw away," "Earthship," "Ignition" and after this phrase, at a precisely stipulated time, the rocket with its operating powerful engines slowly separates from the launch pad and begins its path into space.

"All systems are functioning normally, the flight is going well," say the radio voices from the control point. After several minutes of flight the ship and the cosmonauts have been lifted to the stipulated altitude. Orbital flight has begun. The command-measuring complex has been put into operation. It performs trajectory measurements for the ship's flight. Commands for initiating the programs incorporated in the on-board actuating systems and mechanisms are fed to the ship through telemetric communication channels. Measurements are also made from measurement points located along the ship's flight path in the territory of the USSR. The results of these measurements are automatically transmitted through the communication lines to the coordination-computation center and are subjected to joint processing on electronic computers.

"Soyuz" and "Apollo" Prepare for a Meeting in Circumterrestrial Orbit

At a high-level meeting in Moscow on 24 May 1972 an agreement was signed between the governments of the United States and the USSR on cooperation in the investigation and use of space for peaceful purposes. The agreement provided that in 1975 there would be a joint flight of American and Soviet manned spaceships, their docking and the transfer of cosmonauts

from one ship into the other. After signing of the agreement there were a number of meetings between representatives of the USSR Academy of Sciences and NASA. In these specialists examined the technical problems involved in carrying out the joint flight and worked out the basic principles for making preparations for this complex experiment.

What are the tasks of the impending flight and what are its peculiarities?

In the immediate future, evidently, the principal activity on manned space flights will continue to be in circumterrestrial space. Long-lived orbital stations with an exchangeable crew will make studies of terrestrial resources, track the weather, assist in the investigation of large areas of the land, oceans and polar regions of our planet. The time is coming when the flights of manned ships and orbital stations will become an ordinary thing. The broadening of the scales of space flights will proceed with a constant improvement in space technology, an increase in its reliability. However, an increase in the number of flights will lead to an increase in the probability of the appearance of malfunctions. Assistance to the crew must be rendered within a quite short time and it must be rendered by a spaceship which is ready for launching or even is situated in orbit, independently of what country owns it.

Specially created working groups both in the USSR and in the United States have repeatedly met with one another for working out an integrated program and for successful solution of the three principal conditions for the compatability of the approach and docking systems of spaceships. What are these conditions?

First condition -- compatability of docking apparatus. The fact is that all preceding docking experiments with spaceships were based on the assumption that one of them has an active docking unit and the other has a passive docking unit. But in space any ship can be in an emergency situation. For solution of this problem specialists developed a passive-active or "androgenous" docking unit which after docking enables the cosmonauts to pass from one ship to another through the internal hatches without emerging into open space.

Second condition -- necessity for matching the means making it possible to detect ships in space and accomplishing their approach. This includes systems for radio search and radio interception, matching of frequency and other parameters of radio signals, and also standardization of optical beacons and means for the optical guidance of ships.

Finally, the third condition of compatability is the matching of the parameters of ship atmospheres. The fact is that the atmosphere of the "Soyuz" ship consists of ordinary air at a pressure of 760 mm Hg and the atmosphere in the "Apollo" of pure oxygen at a pressure of 260 mm Hg. Therefore, a direct transfer from a purely oxygen atmosphere to an ordinary atmosphere or vice versa is inadmissible. A special transfer arrangement was developed

for the joint flight of the "Soyuz" and "Apollo" spaceships. It is something similar to a transfer chamber which after docking of the ships will be between the manned compartments on the path of the cosmonauts from one ship to the other.

The sequence for implementing the flight was coordinated. The flight was planned for the second half of 1975. A spaceship of the "Soyuz" type from a Soviet cosmodrome was the first to be launched. A ship of the "Apollo" type was to be launched in the United States after approximately 7.5 hours. There was to be a possibility of launching the "Apollo" on the second and third days after launching of the "Soyuz." However, for a day the "Apollo" was to make an independent flight and then there was to be an approach and docking of the spaceships. In a docked state they form a manned space system which will be controlled and stabilized as an integrated whole. Its orbital flight would last for approximately two days. During this time the plans called for accomplishing mutual transfers of the cosmonauts and the scientific and technical experiments. Television transmissions would be made to earth. Then the cosmonauts would return to their ships and undocking would take place. After completing flight under an independent program there would be a landing: the "Soyuz" in the territory of the USSR and the "Apollo" in the waters of the Pacific Ocean.

Crews were selected and approved for the preparation and implementation of the joint flight of the Soviet and American spaceships in 1975. Below we give the names and concise bibliographic data for both the main and backup crews of the Soviet and American spaceships.

Crews of the "Soyuz" ship:

first crew -- USSR Fliers-Cosmonauts Heroes of the Soviet Union A. A. Leonov and B. N. Kubasov;
second crew -- USSR Fliers-Cosmonauts Heroes of the Soviet Union A. V. Filipchenko and N. N. Rukavishnikov;
third crew -- cosmonauts V. A. Dzhanibekov and B. D. Andreyev;
fourth crew -- cosmonauts Yu. V. Romanenko and A. S. Ivanchenkov.

In March 1965, during flight in the "Voskhod-2" spaceship, Colonel Aleksey Arkhipovich Leonov made an emergence into open space for the first time in history.

In October 1969 Valeriy Nikolayevich Kubasov made an orbital flight in the "Soyuz-6" spaceship as the ship's engineer.

Colonel Anatoliy Vasil'yevich Filipchenko in October 1969 participated in the group flight of the three spaceships as commander of the "Soyuz-7" ship, and in December 1974 made a five-day flight in the "Soyuz-16" ship in which there was testing of the on-board systems and scientific investigations were carried out in accordance with the program for the impending joint experimental flight under the "Soyuz"-"Apollo" program.

In April 1971 Nikolay Nikolayevich Rukavishnikov made an orbital flight in the "Soyuz-10" spaceship as an engineer-researcher and in December 1974 made a second orbital flight together with A. V. Filipchenko in the "Soyuz-16" ship.

Vladimir Aleksandrovich Dzhanibekov was born in 1942 in Yuzhno-Kazakhstanskaya Oblast. After graduating from the Advanced Aviation School in 1965 he received his diploma as airman-engineer. He joined the cosmonaut detachment in 1970.

Boris Dmitriyevich Andreyev was born in 1940 in Moscow. After graduating from the Moscow Higher Technical School imeni Bauman, after 1965 he worked in the design office. He undertook the cosmonaut training program in 1970.

Yuriy Viktorovich Romanenko was born in 1944 in Orenburgskaya Oblast. In 1966 he graduated with distinction from the Advanced Aviation School and received his diploma as airman-engineer. In 1970 he was enrolled in the cosmonaut detachment.

Aleksandr Sergeyevich Ivanchenkov was born in 1940 at Ivanteyevka in Moskovskaya Oblast. After graduating from the Moscow Aviation Institute, beginning in 1964 he worked in the design office. He entered the cosmonaut training program in 1970.

Crews of the "Apollo" ship:

Main crew: Thomas Stafford, ship commander, Vance Brand, pilot of the main module and Donald Slayton, pilot of the docking module.

Backup crew: Alan Bean, Ronald Evans, Jack Loosma.

Thomas Stafford, born 1930, Brigadier General USAF. Served in the USAF after graduating from the United States Naval Academy. In 1959 he graduated from the test pilots school at Edwards Air Force Base. He entered the NASA astronaut detachment in 1962. He made three flights: in the "Gemini-6" spaceship in 1965, in the "Gemini-9" in 1966 and in the "Apollo-10" in 1969. He now occupies the post of deputy director of the Astronaut Training Division Manned Flight Center at Houston.

Vance Brand, born in 1931, holds the M.S. degree. Prior to entering the NASA astronaut detachment in 1966 he was a test pilot for Lockheed. He was a backup member of the "Apollo-15" crew.

Donald Slayton, born in 1924, has a higher education. At the present time he heads the Astronaut Training Division Manned Flight Center at Houston. He has been in the astronaut detachment since 1959. In 1962 he had to drop out due to illness (cardiac arrhythmia), but in 1972, upon being pronounced cured, he returned to the list of "active" astronauts. He had no experience

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

in space flights.

Alan Bean, born in 1932. In 1955 he graduated from the University of Texas as an aviation engineer. He served as a flier in the USAF. He has been in the astronaut detachment since 1963. In 1969, aboard the "Apollo-12" ship, as pilot of the lunar cabin he made a flight to the moon.

Ronald Evans, born in 1933, is a naval officer. He joined the NASA astronaut detachment in 1966. He was pilot of the main module of the "Apollo-17" ship and made a flight to the moon in December 1972.

Jack Loosma, born in 1935, has a higher education. He joined the astronaut detachment in 1966. He flew as part of the second crew in the "Skylab" space station.

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Thus, already in 1975 mankind is becoming a witness of a unique experiment in space which is a qualitatively new stage on the path to man's investigation and use of space. And naturally, the new launchings of the courageous cosmonauts, the new flights of spaceships, will also bring new records indicating the high mission of man, the qualities of his spirit, his eternal aspiration for perfection.

Photo captions: insert between pages 96 and 97

For registry of the records established in a spaceship the International Aviation Federation must receive a protocol of the record flight.

The first artificial earth satellite -- Soviet.

Yu. A. Gagarin. January 1961.

"Vostok" spaceship. In it Yu. A. Gagarin for the first time flew around the earth.

Yu. A. Gagarin and sports commissar I. G. Borisenko after landing.

12 April 1961. The triumphant faces of Moscow's citizens on the streets of the capital.

The chief designer S. P. Korolev congratulates Yu. A. Gagarin after flight into space.

At a meeting with Yu. A. Gagarin at the Central Aerial Club imeni V. P. Chkalov. May 1962.

Thus millions of the earth's inhabitants remembered him [Gagarin].

Gold Medal "Yu. A. Gagarin."

G. S. Titov and his stand-in A. G. Nikolayev in the landing region on 7 August 1961.

A. G. Nikolayev, commander of the "Vostok-3" ship, in a training session before flight.

Soon into space. The "Vostok-4" ship commander P. R. Popovich is ready for flight.

V. V. Tereshkova, flier-cosmonaut, the world's first woman to be in space, on the "Vostok-6."

Academician S. P. Korolev converses with the crew of the "Voskhod" ship. Baykonur. October 1964.

Crew of the "Voskhod-2" ship. P. I. Belyayev and A. A. Leonov (at left) and Yu. A. Gagarin head for the launch pad.

Flier-cosmonaut A. A. Leonov, the first man to enter open space.

Meeting at the Baykonur cosmodrome. Not much time will pass and the new

spaceship "Soyuz-1" with the cosmonaut V. M. Komarov aboard will be put into circumterrestrial orbit.

G. T. Beregovoy is making ready for a launching in the "Soyuz-3" spaceship. October 1968.

Flier-cosmonauts Yu. A. Gagarin, Ye. V. Khrunov, V. M. Komarov, A. S. Yeliseyev, V. F. Bykovskiy.

Flier-cosmonauts A. S. Yeliseyev, Ye. V. Khrunov, V. A. Shatalov and V. F. Volynov in training.

Welcome, earth! The cosmonauts V. A. Shatalov and A. S. Yeliseyev after ending of the flight in the "Soyuz-4" ship.

Crew of the "Soyuz-8" spaceship at the landing site. Ship commander V. A. Shatalov and ship's engineer A. S. Yeliseyev.

Crew of the "Soyuz-6" spaceship; ship commander G. S. Shonin and ship's engineer V. N. Kubasov.

Crew of the "Soyuz-7" spaceship: ship commander A. V. Filipchenko, ship's engineer V. N. Volkov, engineer-researcher V. V. Gorbatko.

Cosmonaut N. N. Rukavishnikov in exercises for study of the ship's scientific apparatus.

Cosmonauts A. G. Nikolayev and V. A. Sevast'yanov, crew of the "Soyuz-9" ship in a trainer ship.

USSR Flier-Cosmonaut, Twice Hero of the Soviet Union A. G. Nikolayev with his daughter Alena.

Crew of the "Soyuz-11" spaceship: V. I. Patsayev, G. T. Dobrovol'skiy and V. N. Volkov at a training debriefing.

Cosmonauts V. N. Volkov, V. V. Gorbatko and sports commissar I. G. Borisenko. Cosmodrome, October 1969.

Baykonur cosmodrome. G. T. Dobrovol'skiy, V. I. Patsayev and V. N. Volkov before landing in the "Soyuz-11" spaceship.

Assembly and checking of "Salyut" station systems.

"Salyut" orbital station and "Soyuz" spaceship (mockup).

Crew of the "Soyuz-12" spaceship: V. G. Lazarev and O. G. Makarov in cabin of spaceship-trainer.

Crew of the "Apollo-11" spaceship: E. Aldrin, M. Collins and N. Armstrong.

Neil Armstrong, the first man treading the lunar surface.

Neil Armstrong speaking at the COSPAR Congress in Leningrad in May 1970.

Launching of a carrier-rocket with the "Soyuz-13" spaceship.

Fragment of lunar map showing landing sites of the "Apollo-11" and "Apollo-12."

Crew of the "Apollo-15" spaceship: D. Irwin, D. Scott and A. Worden.

Astronauts on the moon.

Crew of the "Soyuz-14" spaceship. Ship commander Pavel Popovich (at right) and ship's engineer Yuriy Artyukhin before entry into ship.

Crew of the "Soyuz-15" spaceship — ship's engineer Lev Demin (at left) and spaceship commander Gennadiy Sarafanov during training in the "Soyuz" ship-trainer.

Baykonur. Monument to Academician S. P. Korolev.

Preparations for launching of carrier-rocket with "Soyuz" spaceship.

Assembly-test building for "Soyuz" spaceships.

Antennas of Remote Space Communications Center.